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**CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION**

THE FROST CONTROL PROBLEM WITH SPECIAL REFERENCE TO BLUEBERRIES

STANLEY JOHNSTON
SECTION OF HORTICULTURE

The very destructive frosts of May 12-13, 1938, served to raise the question as to whether it would be profitable to attempt to control frost in blueberry plantations by one of various methods available. Information on this question has been gathered from many sources including investigators in frost control work and the U. S. Weather Bureau, state agricultural experiment stations, fruit growers, and commercial firms.

Whether it is profitable to protect fruit plants against frost depends on several factors. The most important of these in Michigan are: (1) how frequently do injurious frosts occur, (2) can the damage from frost be prevented by one of the known methods of frost control, (3) what will be the cost of frost control in comparison with the value of the fruit saved. Fortunately, with blueberries, permanent injury to the plant itself from low temperatures does not need to be taken into consideration as it does for some fruits in certain places such as citrus trees in California or Florida.

Frequency of Frost Injury

Cultivated blueberries have produced fruit at the South Haven Experiment Station for 14 years and 1938 was the first in which any noticeable frost damage occurred. The next longest fruiting record in Michigan is at Dr. Keefe's Blueberry Plantation at Grand Junction where plants have been fruiting for nine years without apparent injury until 1938.

Weather conditions in the spring of 1938 were unusual. March was very warm, temperatures of 70° to 75° F. being common, and once reaching 80° F. This resulted in vegetation advancing prematurely. April was very dry. In fact the soil became so dry that small plants in nursery beds had to be watered, practically an unheard of thing in a month usually known for its liberal rains. Early May was also rather dry. This dry condition made the frost damage more serious as air heavily laden with moisture is an added protection against frost. The blueberries were in full bloom when the frosts of May 12 and 13 occurred and the temperatures ranged from 18° to 23° F.

The exceptionally warm March in 1938 has already been referred to. According to 73 years of weather records (1865) for Michigan, there has been only one March warmer than in 1938 and that was in 1910. There have been five years (1878, 1894, 1903, 1910, 1921) in which the average temperature of March was as high as in 1938.

Though complete information is not available as to the extent of injury to fruits from frost during those years, it is apparent from available data that injury occurred to some, although the loss of various crops was not always complete. Other factors enter into the question such as the lack of rainfall in April 1938. A change to cooler weather in April, following a warm March, would conceivably lessen the chances of injury. It is possible, for instance, that blueberries would not have been damaged so severely in each of the years in question as they were in 1938. However, if it is admitted that they would have been damaged severely in each of those years, it would mean that the frequency of severe injury would be 6 out of 73 years, or about once in 12 years.

Methods of Frost Control

Different methods of frost control are used, including heating, stirring the air by wind machines, and flooding. The latter is used in cranberry culture but probably would not be a generally satisfactory method with blueberries. Recently there has been considerable interest in the use of wind machines which are constructed by mounting high-powered motors and airplane propellers on platforms at various places in the orchard, or they are mounted on trucks which are driven up and down the rows. Though some apparently favorable reports on the use of these machines have been received from growers and commercial firms, they have not been substantiated by trustworthy experimental data. U. S. Weather Bureau investigators do not have much confidence in those machines. According to their reports, good machines are very expensive, limited in the area they will protect, and they are not effective on nights when there is much "drift" or movement of air.

Workers who have had the most experience in controlling frost almost invariably recommend heaters of some kind, preferably those burning oil as a fuel. Heaters burning solid fuels such as petroleum coke or coal briquets will raise the temperature satisfactorily but are more expensive to operate. There is one serious objection to oil heaters if used in thickly settled areas and that is the dense clouds of smoke and soot produced. It is probable, however, that they could be used one or two nights a year without arousing too much objection from persons living nearby.

All recommendations received from experienced investigators suggest the use of the lard-pail type of oil heater, it being the simplest and least expensive. The standard recommendation is to use 100 of these heaters per acre. All investigators contacted believed that cultivated blueberry plantations could be protected against frost successfully, provided sufficient heaters were available and were properly handled.

Cost of Using Oil Heaters

The following costs are estimates derived from information furnished by investigators with the U. S. Weather Bureau and prices furnished by commercial firms.

Table 1.

Initial Cost of Equipment per Acre		
100—16 qt. lard pail heaters @ .85.....		\$85.00
Storage tank space.....		16.50
Oil barrels, buckets, tank wagon, etc.....		9.75
1 lighting torch.....		2.50
1 thermometer.....		3.00
600 gals. oil (400 gals. in heaters—200 gals. in reserve) @ .075.....		45.00
Lighting fluid.....		1.00
		\$162.75
Operating Costs per Acre		
Interest @ 6%.....	\$9.77	
Depreciation—10% on equipment.....	11.68	
1% on oil.....	.46	
Labor (without firing) setting heaters in plantation, filling, taking up oil heaters, cleaning, storing.....	6.50	
Labor (with one firing).....		\$11.00
Oil (with one firing—average, 350 gals. @ .075).....		23.25
Cost per acre without firing.....	\$28.41	
Cost per acre one firing.....		\$56.16
Cost per acre two firings.....		83.91

NOTE: The amounts allowed for storage tanks, barrels, buckets and a tank wagon are figured for about a 45-acre unit. These costs per acre would be much higher if only a few acres were heated.

The estimated labor costs are based on work done in frost control operations in the Pacific Coast states where heating orchards to prevent frost injury is a common practice. In some orchards, especially of citrus fruits, heating may be done several times a year. Consequently experienced labor is generally available. The situation in Michigan would be different as orchard heating has not been a common practice; moreover, owing to infrequency of damaging frosts, heating is not likely to become common. Consequently, experienced labor would not be available and costs would conceivably be higher through less efficient labor.

To handle properly the heaters on several acres of blueberries would require several men. Owing to the difficulty of assembling a crew of men living at various distances late at night when a frost is expected it would be almost necessary to keep several men at the plantation each night that a severe frost is indicated. Naturally places would have to be provided for them to stay and they would have to be paid, even though they did not actually have to work during the night. This precaution might have to be taken two or three times during the blossoming season as no chances could be taken if the intention was to prevent frost damage by the use of oil heaters.

Another possibility of increased cost would be in the owner's doubt as to whether the frost on a certain night would be damaging to the prospective crop. Watching the temperature drop near the danger

point and at the same time being prepared to heat, the owner's tendency would be to take no chances but to light the heaters. No doubt they would be lighted on certain nights when heating would be unnecessary. This would not have to occur often to increase costs greatly over a 10-year period.

Value of Fruit Lost by Frost

The value of the fruit lost by frost is difficult to estimate owing to the variable amount of injury on plants of different sizes and fluctuations in market prices. The amount of injury to the crop in 1938 was apparently influenced to a considerable extent by the size of the plants. The blossoms on the large plants (5 to 6 feet high) were not injured so much as those on smaller plants (3 feet high and lower). In fact, the large plants produced about two-thirds of a normal crop while the crop on the small plants was practically a complete failure. Probably the blossoms on the large plants were not injured so severely as those on the small plants because most of them were above the coldest air next to the ground. The larger plants also more completely shaded the soil, thereby preventing to a greater extent the loss by radiation of heat stored in the soil.

For the purpose of determining the loss of crop due to the frosts of 1938, the average yields of plants of the standard varieties practically in full bearing are compiled in Table 2.

Table 2. Yields of plants of standard blueberry varieties at the South Haven Experiment Station, 1935-38, inclusive.

Year	Average Age of Plants	Total Yield	Average Yield per Plant in Quarts	Yield in Quarts on Acre Basis
1935	6	5,415	2.14	2,330
1936	7	3,708	1.46	1,590
1937	8	9,107	3.59	3,910
1938	9	2,346	.93	1,004

Total number of plants—2,533

Blueberry plants, like many other fruits, tend to bear a heavy crop one year and a somewhat lighter crop the next. For instance, the 1936 crop (Table 2) was about 32 per cent lower than in 1935. The 1937 crop was exceptionally large. If the same rate of decline had existed in 1938 under normal conditions the average yield per acre would have been 2,659 quarts instead of the actual average yield per acre of 1,004 quarts. The loss in yield of 1,655 quarts per acre between the anticipated and actual yield might all be attributed to frost, although it is likely, because of the exhausting effect of the heavy crop of 1937, that the yield in 1938 would have been lower than normally might be anticipated.

Let us suppose that the Experiment Station plantation had been protected against frost since 1925 when it first came into commercial production. The cost of this protection per acre would have been approximately as follows:

13 years (1925-37, inc.) prepared to heat @ \$28.41...	\$369.33
Cost of firing heaters two times—May 12-13, 1938....	83.91

Total cost of frost protection per acre..... \$453.24

It has been impracticable during the beginning years of our blueberry growing to keep accurate cost of production records on different portions of the plantation. However, it is estimated that the average profit per quart for the years 1934-37, inclusive, was approximately 10 cents. If it is postulated that the entire difference in yield of 1,655 quarts per acre between what actually was harvested and what might normally have been expected in 1938 was due to frost injury, the loss in profit would amount to \$165.50 per acre. Average growing costs for 1935-37, inclusive, were approximately 10.6 cents per quart and this loss of \$175.43 should also be added to the value of the fruit, making a total loss of \$340.93 per acre for 1938.

It has already been shown that the cost per acre of protecting this field against frost damage from 1925 to 1938, inclusive, would have been approximately \$453.24, or a loss of \$112.31 per acre more than what would have been saved, provided no extra expense had been incurred and heating operations in 1938 were successful.

It should be emphasized here that if the grower plans to use heaters to protect his prospective crop, he must have them in readiness to use every year, as no long-range weather forecasting is reliable enough at present to tell what year to expect a killing frost or within a given year what night to expect it more than a few hours in advance.

It should also be made clear that the mere fact the heaters are in the field loaded with oil does not insure protection against frost. Good judgment must be used in determining when and how long it is necessary to fire the heaters. Efficient handling of the equipment is necessary for success.

The cultivated blueberry produces its first crop of important size usually during the fourth season when an average of 1,000 quarts per acre may be expected. During the fifth year the yield may increase to 1,500 quarts; in the sixth to 1,800 quarts, and in the seventh perhaps 2,000 quarts per acre may be expected. From the eighth year and thereafter, average yields should range between 2,500 and 3,000 quarts per acre.

Mention has already been made that small plants suffered a greater loss of their potential total crop than did large plants. Frosts as severe as those in 1938 might be expected to take practically all of the crop on plants four and five years of age and from 80 to 90 per cent of the crop on plants six and seven years of age. The question naturally arises, therefore, as to the advisability of heating the plantation during the fourth to seventh years when the occurrence of frost might cause nearly total loss of crop. This might be especially serious if the plantation is young and has no large bushes which might partially escape the frost. Heating might result in at least a partial crop, the sale of which would return sufficient revenue to meet growing expenses.

If protection is given the plantation only during the fourth to seventh years, inclusive, the cost of protection would be somewhat higher, as the initial cost of the equipment would have to be charged off over four years instead of ten. However, as most plantations are developed

by successive plantings, it is likely that the equipment could be used for nearly the entire 10-year period over which the initial cost of the equipment could be charged off. In that case the cost of heating would approximate the figures already stated.

Average production in a cultivated blueberry plantation during the fourth to seventh years, inclusive, should be about 1,600 quarts per acre. Growing costs have been estimated for 1935-37, inclusive, for plants of all ages at 10.6 cents per quart. (Growing costs include all costs except harvesting.) A total loss therefore, would mean a loss of \$169.60 in growing costs plus about 10 cents per quart profit, or \$160.00, making a total loss of \$329.60 per acre.

The cost of heating has already been calculated at \$28.41 per acre if the heaters are not fired; \$56.16 if fired once, and \$83.91 if fired twice. The chances of getting a frost one year during this four-year period based on weather records would be one in three. It would be very unlikely that more than one frost would occur in this period. If we assume that one year like 1938 will be experienced during this time, it would be necessary to fire twice and not fire during the other three years. This would make the cost of protection for the four-year period total \$169.14. If the one threatened crop was saved, the saving in money value would be \$160.46. The question that must be decided by the grower is whether it is a good gamble to spend \$169.14 to make a profit of \$160.46 with the odds three to one against a frost occurring.

Several factors must be taken into consideration before this question is decided. First, the lowest cost of protection has been taken assuming that the equipment could be used in other parts of the plantation over the full 10-year depreciation period. Second, it is assumed that the crop will be a total loss. A partial crop would offset much of the gain from heating. Third, it is assumed that the heating operations are successfully and efficiently carried out.

This discussion is necessarily largely theoretical because of lack of actual experiments in frost control with blueberries here or elsewhere. However, the report is based on the best information obtainable and probably is reasonably accurate. On the whole it would seem that attempts to prevent frost damage in the average cultivated blueberry plantation in southwestern Michigan, with the best methods known to date, would prove to be unprofitable. If weather conditions should change and frosts become more common, it would probably pay to protect blueberry plantations against possible frost damage. However, this is unlikely as records for more than a hundred years show that weather conditions do not vary much over a long period of time and what has happened before is likely to happen again. Development of some new and more efficient method of frost protection which is less expensive might make it profitable to protect blueberries against frost damage.

This report is based on conditions at the South Haven Experiment Station plantation as it has been in bearing longer than any other in Michigan. The next longest fruiting record in the state is at Dr. Keefe's plantation near Grand Junction. This plantation came into commercial bearing in 1930. Frost damage in 1938 at Grand Junction and South Haven was about the same for plants of the same age and variety. Successful handling of heaters at Dr. Keefe's plantation since 1930 would have resulted in the cost of heating and the saving in crop practically offsetting each other.

Cultural Practices Useful in Preventing Frost Injury

There is one common cultural practice that might be manipulated in such a manner as to give some added frost protection without extra expense and that concerns the time of starting cultivation in the plantation. Fruit growers, especially those raising peaches, have long argued as to the proper time to plow the orchard in the spring. Some have said that it could be plowed safely either before or after blossoming. Others have contended that one invited certain disaster to plow before blossoming because of increasing the chances of injury from frost.

Experiments by the U. S. Weather Bureau* have shown that the temperature in an orchard is lowered by the presence of a cover crop amounting to 0.5° F. at a height of five feet above the ground, and 1.3° F. at a height of ten inches above the ground. While this would be relatively unimportant in an orchard of tree fruits, it might have considerable significance with lower growing plants such as the blueberry.

Even greater differences in temperature over bare soil in a Lloyd George raspberry plantation and an adjacent meadow were found by investigators in England.** On two successive nights, the temperatures at a height of three feet over the bare soil in the raspberry plantation were 5° to 6.5° F. higher than over the adjacent meadow. It is also significant that most of the investigations were conducted in valley bottoms or places suspected of being frost pockets.

The results obtained in these experiments indicate that plowing the blueberry plantation before blossoming might be helpful in reducing injury, especially in that zone from the surface of the soil to the three-foot level. As this is the height which would include the smaller plants whose crop was almost a complete failure in the frosts of 1938, a slight rise in temperature there on a frosty night might conceivably mean the difference between no crop and a partial crop. The lower portions of the larger bushes might also bear a larger crop. It is therefore suggested that the plowing be done and possibly one cultivation completed just before blossoming. If the plantation is so large that there might be some question of completing the plowing before blossoming, it would probably be better to plow plants from three to seven years of age first as they are more susceptible to complete loss of crop from frost injury. Plants younger than three years could be left until the last as they would not be in commercial production.

Investigations by the U. S. Weather Bureau reveal that the temperature often falls several degrees lower at night over wet than over dry ground, because of the heat expended in evaporating moisture from the wet ground during the day. The New Jersey Cranberry and Blueberry Experiment Station has reported greater loss from frost in the poorly drained portions of blueberry plantations. The blueberry plant is very sensitive to moisture conditions. It has been demonstrated that it can easily receive too much and too little water. If land is inclined to be too wet in the spring it should be drained by means of ditches that can be dammed if necessary to prevent too great loss of water later in the season.

*Young, F. D.—“Frost and the Prevention of Frost Damage”—U. S. Dept. Agr., Farmers' Bul. 1588, (Revised) 1935.

**Cornford, C. E.—“Katabatic Winds and the Prevention of Frost Damage”—Quarterly Journal—Royal Meteorological Society, Oct. 1938.

The selection of varieties is also of importance in the prevention of frost injury. Records obtained after the frosts of 1938 indicate that Rubel, Rancocas, Adams, and Jersey are reasonably hardy varieties; they developed nearly two-thirds of a crop on mature plants. Pioneer plants of the same age produced about one-fourth of a crop, while Harding and Cabot proved to be very tender, producing only about 10 per cent of a crop.

As this discussion has primarily been concerned with the problem of preventing frost injury in the established blueberry plantation, no reference has been made to the selection of a site for blueberry growing. The prospective grower in selecting his site should keep the possibility of frost injury constantly in mind. Pockets or sharp valleys with surrounding hills nearby should be avoided. Wide, open areas with hills considerably removed and opportunities, if possible, for cold air to drain to lower levels, are desirable.

THE RESISTANCE OF CERTAIN Highbush BLUEBERRY VARIETIES TO INJURY BY FROST

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Plants of the improved varieties of the cultivated blueberry were first planted at the South Haven Experiment Station in 1923 and these plants fruited for the first time in 1925. New plantings have been made almost yearly since that time and fruit production has been very satisfactory. No noticeable frost damage occurred until the spring of 1938 when two exceptionally severe frosts on May 12 and 13 during full bloom greatly reduced the potential crop.

This occurrence offered an opportunity to observe the resistance of blossoms of a number of standard blueberry varieties to frost injury. Accordingly blossom counts were made on small branches of each of seven varieties. The counts on each variety were scattered as widely over the plantation as possible in order to avoid making all of them in some spot that possibly had been colder than others. After the fruit had set and the berries had grown to about three-fourths of their mature size a count was made of the number of berries developing on each of the small shoots on which the blossoms had been counted previously. The percentages of blossoms that had escaped frost injury and set fruit was then determined. The results are presented in Table 1.

In his work on blueberry pollination Merrill* estimated that about an 80 per cent set of blossoms is necessary for a full crop. Data presented in Table 1 show that the per cent of fruit set on the different varieties was considerably below this figure. Harding and Cabot were particularly susceptible to frost injury while Pioneer was only slightly better.

*Merrill, T. A.—Pollination of the Highbush Blueberry—Tech. Bul. 151, Mich. Agr. Exp. Sta. 1936.

Table 1. Percentages of blossoms remaining uninjured and setting fruit of different blueberry varieties following the severe frosts of May 12-13, 1938.

Variety	Number Blossoms	Number Berries	Per Cent Developing Fruits*
Rancocas..	535	310	57.9
Rubel...	807	462	57.2
Adams...	435	220	50.6
Jersey...	580	283	48.8
Pioneer...	652	184	28.2
Harding...	668	134	20.1
Cabot....	477	51	10.7

*These percentages closely approximate those that escaped frost injury as most of those that did escape set and matured fruit.

The blossoms counted were all on old plants, standing from four to six feet high. The crop was nearly a complete failure on smaller plants of the same varieties and on several thousand comparatively small seedlings. Probably the blossoms on the large plants were not injured so severely as those on the small plants because most of them were naturally located higher and therefore farther removed from the coldest air nearer the earth's surface. The larger plants also more completely shaded the soil, thereby preventing to a greater extent loss by radiation of heat stored in the soil.

Following the frosts many blossoms showed unmistakable signs of injury within a few hours. The flowers turned dark brown and the pistils were black near the base. Others, however, showed only a moderate amount of browning and the pistils to all outward appearances were all right. To test whether these apparently moderately injured blossoms would set fruit, counts were made on a number of them on plants of four different varieties. All uninjured and badly injured blossoms were removed. The results of this test are shown in Table 2.

Table 2. Percentage of fruit set on blossoms showing a moderate amount of discoloration due to frost injury.

Variety	Number Blossoms	Number Berries	Per Cent Set
Pioneer	91	9	9.9
Rubel	64	5	7.8
Jersey	50	0	0.0
Cabot	54	0	0.0

The data presented in Table 2 show that the blossoms having a moderate amount of brown discoloration were apparently injured sufficiently to prevent fruit setting entirely in the case of Cabot and Jersey and to reduce it to 7.8 and 9.9 per cent, respectively, for Rubel and Pioneer.

FLAVORING CHARACTERISTICS OF INDIVIDUAL COCOA VARIETIES

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Although the individual flavoring characteristics of particular types of cocoa beans are mentioned in a few texts, the character of the liquor from these beans when used unblended and unflavored in the ice cream mix has not been studied. Practically all cocoas and chocolates on the market are blends, made to the manufacturer's ideal of a standard commonly acceptable to the public.* The manufacturer has had in mind, perhaps, economy, color standards, and a product which is difficult for competitors to match.

Causes of Quality Variation

Soils, climate, elevation, precipitation and season are said to cause great variations in quality in beans from the same kind of trees from season to season. Whether these differences from year to year are great, whether the average differences between beans grown in varying habitat are great or small, and whether the differences between beans from the same stock are greater than between those beans grown in different sections of the world are unknown to the ice cream manufacturer.

Information is scarce, also, as to public preference for those qualities of chocolate which blend best with ice cream. However, attention has been given to the subject as applied to use in beverages, Whymper (3) being one to attribute lowered consumption of cocoa in England to the use of the stronger, more bitter chocolate grown in Britain's African cocoa plantations.

Description of Cocoa Beans

Knapp (1) accepts Morris' classification of cocoa beans into two varieties, Criollo and Forastero, the former being much the better type. There are many sub-varieties of the latter. By some authorities a third distinct variety is added, Calabacilla, commonly considered inferior to Forastero.

In this work seven representative varieties of cocoa beans were selected on the New York markets as follows:

VARIETY	SOURCE
1. F. F. Accra	Africa
2. Arriba	Ecuador
3. Superior Bahia	Brazil
4. Puerto Cabello	Venezuela
5. La Guaira Caracas	Venezuela
6. Sanchez	West Indies (strong type) (San Domingo)
7. Trinidad	West Indies (fine type)

*Excepting coffee, the United States imports more cocoa than any other food product. In 1938 453,097,000 pounds valued at \$20,139,000 were imported, and in 1937, 619,051,000 pounds valued at \$52,331,000.

These beans are described by several authorities.

1. **Accra.** Bywaters (2) describes the beans as dark brown to violet, with mildly acid to harsh bitter flavor, used as a base chiefly in cheaper chocolates and cocoas. Whympster (3) describes them as Forastero-Amelonado varieties, carelessly fermented, of lowest quality on market—excepting possibly those from Haiti, often moldy, dirty brown in color, and harsh and bitter in flavor.

2. **Arriba.** Knapp states that this variety possesses a fine strong flavor and characteristic aroma, but is unscientifically cured. Bywaters states that it is the Forastero type, has an unique scented aroma and characteristic flavor impossible to obtain from other beans, is priced highly, but is often imperfectly dried, making the beans subject to mold. Whympster classifies it as the Forastero type, rich dark brown in color, often incompletely dried, friable, and possessed of a sweet, fine scented flavor.

3. **Bahia.** Knapp describes the Bahia as not so fine as the Arriba, but better fermented. Bywaters states it is about like Accra, of Forastero origin, improperly dried, graded, and cared for, brown to violet in color, the best grades commanding a high price. Whympster describes it as very ordinary and uninteresting, smoky red brown to brown violet in color, clayed, poor, bitter, and often harsh in flavor.

4. **Puerto Cabello,** according to Bywaters, is of the very desirable Criollo type, rich brown in color, possesses a sweet flavor, and varies greatly in quality; and, according to Whympster, should be the finest Criollo and the best cocoa grown in the world but that other varieties are sometimes included in this grade.

5. **La Guaira Caracas.** Knapp believes this variety—Criollo type—the finest cocoa grown; Bywaters classifies it as the Criollo variety, pale to deep brown, invariably clayed, and having a strong, agreeable taste; and, Whympster states that it is almost entirely of Criollo origin, lower priced than Puerto Cabello but of very fine quality with fine full, sweet, nutty, and pronounced chocolate aroma.

6. **Sanchez.** Knapp asserts that this type cocoa is little appreciated in Europe, the bulk being exported to America, and that a fair proportion is inferior; Bywaters states that it is sometimes classified as Samama, is deep violet in color, and, in flavor, poor and bitter; and, Whympster states that it is clayed, which gives it a brilliant dark brown to purple color, but that it has a poor, unpleasant, bitter flavor.

7. **Trinidad** is regarded by Knapp as a very uniform cocoa, scientifically cared for, and long known for its excellence; by Bywaters as of Forastero origin, claying prohibited by law, red brown, uniform, and of high quality; and, by Whympster, as entirely of the Forastero variety, most uniform of all cocoa, red brown, subject to mold, slightly bitter but having fine chocolate flavor, and second only to Ecuador cocoa.

The foregoing descriptions are entirely by English writers and probably reflect British taste in this respect.

The quality of these varieties might be rated as follows as given by the foregoing authorities. Other significant data are also given.

Table 1. Average quality, production and price of cocoas.

Variety	Quality Rating	Production	Price N. Y. Market May 4, 1939 (cents)
1. F. F. Accra.....	Sixth.....	First.....	4.5
2. Arriba.....	Third.....	Fifth.....	8.0
3. Bahia.....	Fifth.....	Second.....	4.5
4. Puerto Cabello.....	First.....	Sixth.....	12.0-18.0
5. Caracas.....	Second.....	Seventh.....	10.0
6. Sanchez.....	Seventh.....	Third.....	4.1
7. Trinidad.....	Fourth.....	Fourth.....	7.5

Flavor

Whymper has found that roasting removes much of the vinegary flavor, but that, generally, the darker the color the more bitter the flavor. The flavor of commercial chocolate and cocoa, however, is in many cases modified by the addition during milling of vanillin, essential oil of almonds, cinnamon, cassia, ginger, tolu balsam, and other materials.

Trials with Chocolate Varieties

In these trials involving the flavoring characteristics of beans, the seven varieties mentioned were procured on the New York market and processed and milled separately through the cooperation of Runkel Brothers, Inc. These chocolate liquors were analyzed for ash, fat, and pH. They were homogenized into ice cream mix at varying rates and the samples numbered and served to consumers with the request that these persons place the samples by number in order of preference.

The mix was prepared from 40.0% cream, 4.0 % milk, skimmilk powder, sugar, and gelatin. This mix tested 11.92 per cent fat, 10.06 per cent serum solids, 37.17 per cent total solids, 15.02 per cent sugar, and 0.2 per cent gelatin. The mix was divided into seven equal parts. To each part was added a different variety of chocolate liquor in rates varying from 1 to 2½ pounds for 43 pounds of the mix. The mixture was then pasteurized, homogenized, aged for 24 hours, and frozen.

Ash Analysis

Ash content has been considered as an indication, to an extent, of the amount of earth left on the shell. However, the importation of clayed cocoa beans is at the present time prohibited in the United States. Whymper states that ash varies from 2.71 to 8.73 per cent. With improvements made in cocoa bean handling it would be expected that ash content today would be more uniform than that reported by the author mentioned. The same writer cites analyses for cocoa fat in the roasted beans as varying from 37.63 to 52.09 per cent.

The percentages of ash found in the chocolates were as follows:

Table 2. Percentage ash in seven chocolate varieties.

Variety	Accra	Arriba	Bahia	P. Cabello	Caracas	Sanchez	Trinidad
Ash (Per cent) . . .	3.56	2.65	3.21	3.27	3.51	2.74	3.47

These values are remarkably uniform and would indicate that claying during curing may be much less frequent than at the time of the writers previously cited. Caracas, mentioned as being invariably clayed, has the same ash content as Trinidad in which claying is prohibited by law. Sanchez, which was mentioned as often being clayed, is second lowest in ash of all varieties tested.

These results not only indicate that amount of ash in these examples plays no part in flavor but also that no appreciable amount of alkali was added for "Dutching" or for neutralization of acid. No attempt was made to analyze the ash, although particular minerals present conceivably could affect the taste.

pH Determinations and Fat Content

Usually during the processing of cocoa beans the pH is adjusted to a predetermined standard. The pH values and the fat content of these samples follow:

Table 3. pH and cocoa fat content for each variety.

Variety		pH	Cocoa Fat (per cent)
1.	Accra	5.67	54.95
2.	Arriba	5.85	52.80
3.	Bahia	5.30	53.85
4.	Puerto Cabello	5.65	51.31
5.	Caracas	5.41	51.85
6.	Sanchez	6.03	51.62
7.	Trinidad	5.97	52.92

All pH determinations were made on 10 per cent suspensions in water using the quinhydrone method. The results are suggestive not only as showing the degree of acidity in natural, untreated chocolate liquors but because they correlate approximately, though not significantly, with flavor.

Fat analysis was made by the official method (4). The results show that all of the beans used were very similar in cocoa fat content and would leave little choice so far as increasing mix fat composition is concerned.

Viscosity

Mixes containing different chocolates were checked for viscosity despite the fact that different chocolates could be expected to have little, if any, effect on this factor. Results were so erratic that it is believed no conclusions should be drawn.

Public Preference for Chocolate Varieties

Samples of these different chocolates made into ice cream and designated only by number were given to 297 consumers of ice cream, chiefly students and faculty members, with the request that each carefully place the samples for flavor in order of preference. It is very questionable whether even a majority of the samples were carefully judged, and herein lies the most questionable value in any consumer preference test, especially where the product like ice cream is such

a popular favorite. Much critical judgment is lost or given scant attention in the pleasure of consuming. Second, it is doubtful if the average consumer, untrained in distinguishing between slight differences in flavor, is able to note sufficiently the existing differences. Also, it is the experience of ice cream manufacturers that in too many cases the public is likely to mistake quantity of flavor for flavor quality. Most manufacturers believe in supplying what the consumer wants, rather than educating him to an ideal flavor.

Table 4. Consumer ratings for chocolate varieties.

Sample No.	Cocoa Variety	Average Weighted Rating	Placing	Accepted Expert Rating
1	Accra	3.82	5	6
2	Arriba	3.17	7	3
3	Bahia	4.19	3	5
4	Puerto Cabello	4.45	2	1
5	Caracas	3.74	6	2
6	Sanchez	4.10	4	7
7	Trinidad	4.50	1	4

If the commonly accepted rating of experts is compared with that of the public, the results are as follows: Puerto Cabello placed first by experts was placed second by the public; Caracas placed second by experts was placed sixth by the public; Arriba was third by experts, seventh by the public; Trinidad fourth and first respectively; Bahia fifth, and third; Accra sixth and fifth; and Sanchez seventh and fourth. With the exceptions of Puerto Cabello and Trinidad, the persons sampling these varieties appeared to prefer a rather strong, slightly bitter type chocolate in ice cream.

Experienced judges also scored the samples. In all, 26 scorings are averaged in Table 5.

Table 5. Experienced judges' ratings.

Sample No	Chocolate Variety	Average Weighted Ratings	Placing	Expert Accepted Rating	Public Placing
1	Accra	4.20	4	6	5
2	Arriba	4.15	5	3	7
3	Bahia	5.77	1	5	3
4	Puerto Cabello	5.73	2	1	2
5	Caracas	3.54	6	2	6
6	Sanchez	3.08	7	7	4
7	Trinidad	5.19	3	4	1

In general, it will be seen that the experienced judge placings follow rather closely those of the public, preference being shown in the main for the stronger chocolates. In both cases, Puerto Cabello, reputed to be a delicate chocolate bean of the desirable Criollo type, was deemed excellent.

The experienced judge score included criticisms. Accra was characterized variously as good, slightly bitter, licorice, strong, not rich, bitter, brackish; Arriba as good, but lacking in flavor and character;

Bahia as good, superior, mild, and pleasant; Puerto Cabello as very good, rich, and very slightly woody; Caracas as not typical, smoky, strong licorice, smoky and slightly burned; Sanchez as peculiar pink color, scorched, lacking true chocolate flavor, lacking flavor, foreign flavor, woody, and off flavor; and Trinidad as very slightly licorice, slightly burned, mild, superior, and very good.

Summary

In an effort to measure the preference of the public for chocolate flavors peculiar to particular varieties, ice creams of identical composition were flavored with chocolates prepared from one variety of bean without the addition of other varieties or extraneous flavoring extracts. They were also analyzed chemically.

Ash and fat content of all varieties used were very nearly identical but variations occurred in the pH.

Public preference for flavor of chocolate varieties in ice cream would seem to incline to the stronger varieties of beans having chocolate flavor of the bitter type. As is the case with maple-flavored ice cream, a stronger flavored maple than the ordinary grade is necessary to show through the dilutant action of the ice cream mix. So with chocolate ice cream, the milder flavors may be so subdued by the ingredients of the mix that the stronger varieties are necessary to impart desired flavor. Chocolate in beverages is not subjected to such handicaps. To avoid seasonal changes in flavor and to provide color and the desirable effects of more than one type of bean, the practice of manufacturers in blending several varieties of cocoa beans to produce a brand suited to specific use seems amply justified. In general, it may be said, that in processing, the purpose of supplying body, flavor, and color by using particular varieties adapted to each, some sacrifice of one or more of these properties may be necessary.

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THE PRESENT STATUS OF ARTIFICIAL INSEMINATION

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SECTION OF ANIMAL HUSBANDRY

The increasing use of artificial insemination of livestock in Russia and continental Europe during the last few years has helped to stimulate a great interest in this method of breeding throughout the United States.

The idea is not a new one, but the methods now being used are entirely different from any previously tried. The Russians, prompted by necessity, were the first to develop proper technics and organizations for the practical utilization of their methods. From there, interest has spread and research has been initiated in nearly every livestock country of the world. Sufficient progress has been made so that in many instances profitable use of artificial insemination can now be made; it is being used extensively in the large governmental breeding centers in Russia. Cooperative dairy associations in Denmark and elsewhere are using the method with marked success.

In the United States, the first breeding unit was organized in Minnesota in 1937, largely on an experimental basis. In May 1938 New Jersey organized a farmers' cooperative breeding society with 102 dairymen entering 1,050 cows. The results were so satisfying that the organization has grown rapidly and at present more than 4,500 cows are being bred artificially in that state. Two active organizations have been operating in New York since November 1938 and plans are under way for the organization of additional breeding centers.

Wisconsin has two operating units and Michigan, Missouri, Nebraska, California, Mississippi, Maine and others are operating units or working on the problems of artificial insemination.

There are a number of ways in which artificial insemination may prove useful to the livestock industry, but it can never be expected to be a panacea for all the ills of the industry. It will not cure all the breeding troubles now being encountered.

(1) It will, however, make it possible to evaluate a young sire earlier in his life than is possible by regular breeding. One of the practical problems in animal breeding is proving sires early enough in life so that the information may still be used to discard the poor sires before they have done too much damage and to utilize fully the good ones while they are still potent.

Through artificial insemination the service of a bull or ram may be extended 10 to 12 times and a stallion 3 to 4 times. This is possible because a single ejaculate can be diluted and divided so that from 5 to 20 females can be inseminated with one ejaculate. Through proper organization, it will be possible to inseminate one or two females in a large number of herds. In this way, a true random sample of a male's ability as a sire will be obtained and a large sample will be obtained on the first crop of offspring.

(2) A second use closely identified with the first mentioned is the increased use that can be made of proved sires. This will be realized both by the fact that they can be proved while still young and by the greatly increased use that can be made of those sires once they are proved.

(3) Valuable sires that because of a physical handicap (such as size, age, or a crippled condition) cannot make a satisfactory service, may in many cases be used successfully with artificial insemination.

(4) Artificial insemination can also be a helpful instrument in disease control.

(5) Breeding efficiency may be increased where vaginal infections are prevalent.

Limitations

Some of the limitations of artificial insemination are:

(1) The work is time-consuming, and a well-trained operator is required. It is, therefore, apparent that the service cost per female may be as great as with direct mating.

(2) Some special instruments and equipment are necessary but they need not be expensive.

(3) The instruments must be kept immaculately clean or infection may be widely distributed.

(4) When semen is transported, care must be taken to guard against the spread of certain diseases.

Several methods have been developed for the artificial collection of semen and probably two of them stand out as being of the greatest value.

(1) The artificial vagina for collection with normal vigorous males.

(2) Massage of the ampullae for collection from males that are crippled, slow or in any way physically handicapped.

Of the many instruments developed for the insemination of the female, probably no one group stands out, although the author favors all Pyrex glass equipment because of the ease with which it is sterilized.

A great deal of work has been done in the way of developing solutions for diluting semen and methods of storage. Up to the present time, satisfactory advance has been made and sheep sperm may be kept fertile for several days. Work is in progress so that very soon we may expect to be able to preserve cattle and horse sperm for as long a period of time.

At the present time, it is possible to preserve cattle sperm for a long enough period of time so that breeding organizations can function efficiently.

Enough trials in Russia, western Europe, and the United States have been conducted to demonstrate that artificial insemination not only is workable but practical. To use it successfully and most effectively some cooperative type of organization is usually necessary. For the larger operators in this country, cooperative organizations will not be necessary, but if the average farmer is to get the benefit of superior germ plasm, then organizations seem to be essential.

Artificial breeding probably has its greatest possibilities in the cattle and horse industries, although it may eventually serve a purpose with other types of livestock.

In communities where a large number of cattle are located in a rather small area, community farm projects or organizations of small breeders probably offer the best opportunities. Artificial insemination will not replace the herd sires on large dairy farms, but in time it may replace the sires in small herds as well as give the small breeder an opportunity to obtain the use of a proved sire of outstanding transmitting ability.

The actual procedure involved in the collection of semen and insemination of females is neither extremely difficult nor involved, but certain definite knowledge and precautions are necessary. Therefore some control and regulatory measures seem to be advisable. If the work is done carelessly or by persons not trained in the technics, it is possible and probable that diseases may be spread and injuries to either the male or female may occur. Breed associations are now formulating plans to regulate the registration of animals produced as a result of artificial insemination.

Summary

Artificial insemination has been developed to the point where it can serve the livestock industry. It presents a solution to the proved sire problem by offering a method whereby a sire may be proved more surely and at a much younger age and when he is proved his use may be increased from 10 to 12 times.

In addition, artificial insemination presents the livestock breeders with the possibilities of building superior strains of livestock around a proved sire so that large populations may be built up that are carrying the same superior germ plasm.

It seems likely that breeders can anticipate rapid progress from the future use of artificial insemination as they become organized so as to use it efficiently, but we cannot expect its use to be a cure-all for every breeding trouble. It can only serve as a very useful tool to the livestock industry and when used as such may well become a factor in the most rapid improvement in the great mass of livestock that has ever been known.

A SURVEY OF MICHIGAN MASTER BUTTERMAKERS CONTEST FOR 1937-38

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Michigan is one of the larger butter manufacturing states, now ranking fourth in quantity output with a production record for 1937 of 82,167,000 pounds. This butter is made in 250 creameries of varying size. There are 38 creameries each making more than 500,000 pounds of butter annually. These 38 creameries make 65 per cent of the butter.

In order to stimulate interest and skill in buttermaking technique, as well as to further improvement in quality and economy, an efficiency contest has been sponsored cooperatively by the State Bureau of Dairying and the Dairy Extension Service of Michigan State College. This

contest was begun in 1928 and for 10 years was conducted on the basis of comparative skill in judging, in the analysis of the product, and in the control of composition. From 30 to 60 creameries have been entered in this contest each year. However, because of the contest features, several entrants withdrew when they believed that they no longer were in position to be among the winners.

Results are herewith presented on the butter entered in this Michigan Master Buttermakers Contest for one typical year, 1937-38.

Procedure of Conducting Contest

Twelve 5-pound cartons of butter were submitted to the Dairy Extension Service of Michigan State College by each entrant during the contest. The butter was judged and scored for flavor, body, salt, and color by a committee of two or three judges. The buttermaker's grade on scoring was the difference between his score on the butter and the official score of the committee.

Prior to the submission of the sample, the buttermaker analyzed the butter for fat, moisture, salt, and curd. Upon the receipt of the butter at the College, it was analyzed by the Office of the Agricultural Chemist, State Department of Agriculture, Lansing. Again, the buttermaker's grade on analysis was the difference between his analysis values and those obtained by the Agricultural Chemist.

The third feature of the contest involved the control of the composition of the butter. During this period, a maximum moisture content in the butter of 15.9 per cent was arbitrarily used as the standard. The buttermaker attempted to standardize the moisture content of his butter to this value. The deviations of his actual values from this standard constituted the buttermaker's grade in this connection.

In addition to scoring and analyzing the samples of butter submitted in the contest, yeast and mold determinations were also made by plating the sample on acidified malt agar. The yeast and mold results were not used in arriving at the buttermaker's grade, but were returned to the buttermaker as a means of informing him of the sanitary quality of his butter.

Results of Contest

Score of Butter

A total of 328 lots of butter were judged and scored during the 1937-1938 period. The distribution of the scores of this butter is shown in Table 1.

This table shows that the bulk of the samples fall within the range of 88.5-91, with 241 samples or 73 per cent of the total scoring within these values. Fifty-two per cent of the samples scored within the range of 88.5-90, whereas 91 samples, or 28 per cent, scored above 90.

The quality of the butter, to some extent, appeared to be related to the size of the creamery. The score of the butter in relation to creamery output was determined for 25 creameries that completed the contest by sending in the 12 required samples. These results are presented in Table 2.

It is apparent from Table 2 that the average score of butter, when based on pounds made by the contributing creameries is higher than when only the scores are averaged, as was done in Table 1. The

Table 1. Distribution of scores of butter in Michigan master buttermakers contest, 1937-38.

Score Range	Number of Samples	Per Cent Distribution
Over 92.0	4	1
91.5-92.0	19	6
90.5-91.0	68	21
89.5-90.0	76	23
88.5-89.0	97	29
87.5-88.0	45	14
87.0 and below	19	6

Average Score 89.6

creameries making from 500,000 to 1,000,000 pounds had the highest scoring butter, with a weighted average of 90.6.

Nine creameries making over one million pounds annually had a weighted average score of 90.2, while 10 creameries making from 100-300 thousand pounds annually had a weighted average score of 89.

Table 2. The relation of the quality of butter to the creamery output.

Size (Annual Production in Pounds)	Number of Creameries	Butter Production per Annum (Pounds)	Average Score
Over 1,000,000	9	21,337,721	90.2
500,000 to 1,000,000	3	1,575,475	90.6
300,000 to 500,000	3	1,081,336	89.6
100,000 to 300,000	10	1,991,123	89.0

Weighted average score based on pounds of butter 90.1

Buttermaker's Ability to Score Correctly—As previously explained, the ability of each buttermaker to score his own butter was measured by comparing his score with that of the committee of judges. The results show that the buttermakers vary widely in this respect. This is illustrated by Table 3.

The results presented in this table show that a few of the contestants were capable of scoring remarkably close to the official score; i.e., deviating on the average not more than 0.5 points, whereas there were also a few who were decidedly poor in this respect, averaging

Table 3. Ability of buttermakers to score butter.

Average Variation from Official Score	Number of Buttermakers
0.5 points and less	3
0.51 to 1.00	13
1.01 to 1.50	16
1.51 to 2.00	2
Over 2.00	4

more than 1.5 points from the official score. Slightly more than one-third of the 38 contestants scored the butter on the average within one point of the correct score, whereas there were an equal number whose scores deviated within the range of 1.01 to 1.50 points.

Analysis of Butter—The four major constituents of butter concerned in the analysis of butter by the buttermaker, and also involved in the control of composition are the milk solids-not-fat which are, for convenience, classed as "curd," the butterfat, the salt, and the moisture. The buttermaker usually attempts to control the fat content of the butter indirectly by controlling the amount of curd, salt, and moisture.

Curd Content of Butter—The average curd content of the 328 samples of butter was 0.72 per cent, and 68 per cent of the samples contained between 0.6 and 0.8 per cent curd. Only 12 samples were found to have a curd content exceeding one per cent, with the highest individual sample containing 2.95 per cent.

When attention is given to the average curd content of butter submitted from any one creamery, the results show that only two buttermakers submitted butter averaging more than one per cent. These results are presented in Table 4.

Table 4. Distribution of average curd content of butter submitted in master buttermakers contest, 1937-38.

Average Curd Content (Per Cent)	Number of Contestants
Less than 0.5.....	0
.5 to .6.....	4
.6 to .7.....	13
.7 to .8.....	13
.8 to .9.....	4
.9 to 1.0.....	2
1.0 and over.....	2

This table shows further that 30 of the 38 contestants submitted butter averaging not more than 0.8 per cent curd.

Salt Content of Butter—Uniformity of salt content in butter is desirable from the standpoint of uniform composition and public demand for butter of certain salt taste. Variation to a high degree was found in salt content of butter from the same creameries. These variations from the extreme high to the extreme low are shown in Table 5.

Only 9 buttermakers maintained a variation in salt content of less than 0.5 per cent, while 23, or 60 per cent, permitted salt variation in their butter in excess of 1 per cent.

Table 5. Variation in salt content of butter submitted by the same contestant.

Variation (Per Cent)	Number of Contestants
0 to 0.5.....	9
.5 to 1.0.....	6
1.0 to 1.5.....	14
1.5 to 2.0.....	5
Over 2.0.....	4

Table 6. Distribution of salt content of butter submitted in master buttermakers contest, 1937-38.

Salt Content (Per Cent)	Number of Samples
Less than 2	14
2 to 2.5	59
2.5 to 3.0	167
3.0 to 3.5	62
3.5 to 4.0	19
4 and over	7

The average salt content of all the butter analyzed was 2.80 per cent. The variation of salt content ranged from 1.09 per cent to 4.70 per cent. Table 6 shows the distribution of salt content of the butter analyzed.

Apparently most contestants desired to incorporate from 2.5 to 3 per cent salt in their butter. Approximately one-half of the samples fell in this group. It would seem that those samples containing such high amounts as to be above 3.5 per cent or such low analyses as less than 2 per cent are due to faulty workmanship in buttermaking.

Moisture Content of Butter—At the time this portion of the contest was being conducted, Michigan's butter was under a double standard which regulated fat and moisture. According to this standard, the butter must contain not less than 80 per cent fat and not more than 16 per cent moisture. Butter which was sent to out-state markets was regulated to conform to the Federal standard of 80 per cent fat. Contestants from a few creameries whose butter was largely sold to out-of-state markets submitted a moisture standard to which their butter was to conform.

The moisture content of butter sent in for analysis during 1937-38 varied from 13.65 per cent to 19.78 per cent, with an average for all 328 samples of 15.95 per cent. Table 7 shows the distribution of moisture analyses of these samples. Since most of the contest entrants were endeavoring to make butter containing 15.9 per cent moisture the bulk of the analyses should be expected to be close to that figure. Two hundred and twenty-five samples were in the 15.5 per cent to 16.5 per cent range and were approximately within 0.5 per cent of the moisture percentage they sought to incorporate. Recklessness in moisture control was apparent in 46 samples testing more than 16.5 per cent;

Table 7. Distribution of moisture analyses of butter entered in Michigan master buttermakers contest, 1937-38.

Moisture Content (Per Cent)	Number of Samples
Less than 14.0	2
14.0 to 14.5	5
14.5 to 15.0	18
15.0 to 15.5	32
15.5 to 16.0	118
16.0 to 16.5	107
16.5 to 17.0	37
17.0 and over	9

Table 8. Moisture control ability of buttermakers.

Average Per Cent Difference from 15.9		Number of Contestants
Less than 0.2	5	5
0.2 to 0.3	10	10
0.3 to 0.4	6	6
0.4 to 0.5	5	5
0.5 to 0.6	4	4
0.6 to 0.7	4	4
0.7 to 0.8	3	3
Over 0.8	1	1

whereas other lots, too low in moisture content, showed failure on the part of the buttermaker to make full use of butterfat.

The ability of the contestants to control the moisture content to a fixed value is further illustrated by Table 8. Five contestants averaged less than 0.2 per cent from 15.9 per cent, while 10 others averaged less than 0.3 per cent. This should be considered excellent workmanship. Twelve contestants had average moisture variation in excess of 0.5 per cent, with one individual in excess of 0.8 per cent. These variations seem unnecessarily high.

Fat Content of Butter—As noted previously, the control of moisture and salt, and a definite knowledge of the amount of curd makes it possible for buttermakers to closely control the fat content of the butter. The results of the study of the fat content of the butter submitted in the 1937-38 contest are shown in Table 9.

Table 9. Fat content of butter in master buttermakers contest, 1937-38.

No. of samples analyzed	328
No. of samples testing over 80% fat	269
No. of samples testing under 80% fat	59
No. of contestants	38
No. of contestants with all samples over 80% fat	16
Average fat test of all samples	80.50
Average fat test of all samples testing over 80% fat	80.77
Average fat test of all samples testing under 80% fat	79.13
Average fat test of contestant samples with all butter over 80% fat	80.80

Eighty-two per cent of the samples were found to contain more than 80 per cent fat, whereas 18 per cent of the samples contained less than 80 per cent and would be classed as illegal butter. Sixteen buttermakers, or less than 50 per cent of the contestants, submitted samples all of which were above 80 per cent fat.

The average fat content of all of the samples analyzed was 80.5 per cent, whereas the samples testing above 80 per cent fat averaged 80.77 per cent fat. The average fat test of 59 samples testing under 80 per cent fat was 79.13 per cent. The fat content of butter of the 16 contestants who had no butter below 80 per cent fat was 80.80 per cent.

Ability of Buttermakers to Analyze Butter Correctly—One prerequisite of a good buttermaker is that he be able to analyze butter correctly. This is necessary if he is to control properly the composition of the butter. Therefore, since this is an important angle, the grade of the buttermaker in this contest was based partly on his ability

Table 10. Average difference between buttermakers' analyses of butter and the official analyses.

Difference	Number of Buttermakers
.5 and under.....	2
.75 to .5.....	9
1.00 to .75.....	9
1.50 to 1.00.....	8
2.0 to 1.5.....	3
2.0.....	7

to correctly analyze the butter. The average results are presented in Table 10.

This table shows the difference between the buttermakers values for fat, moisture, salt, and curd, and those obtained by the State Chemist. These results show that 18, or approximately one-half of the buttermakers, differed from the official by more than one point, whereas approximately one-fourth of the contestants differed by more than 1.5 points. On the other hand, about one-fourth of the contestants differed from the official by not more than 0.75 point.

General Composition Control—In analyzing the data collected, some attention was given to determine whether the control of composition in the butter could be related to the size of the creamery. In general, it might be expected that the larger creameries would be more efficient in this control than smaller creameries due to superior laboratory facilities and perhaps better trained men. The results, as presented in Table 11, would tend to bear out this assumption.

Table 11. Control of butter composition by creameries of different sizes.

Size Creamery (Annual Pounds Production)	Average Composition Overrun	Average Salt Per Cent	Average Curd Per Cent	Average Moisture Per Cent	Average Fat Per Cent
100,000—300,000.....	23.94	2.88	.68	15.76	80.68
300,000—500,000.....	23.80	2.69	.65	15.89	80.77
500,000—1,000,000.....	24.70	2.99	.74	16.08	80.19
Over 1,000,000.....	24.54	2.73	.69	16.29	80.20

Control of Yeast and Mold—As noted under the procedure, macroscopic determinations for one year on yeast and mold were conducted on each entry of butter during the 1937-38 contest. The yeast and mold count as previously mentioned was not used in connection with the contest, but the results were relayed to the buttermaker for his own information. The results on yeasts and molds are shown in Table 12.

A marked difference was noticed in the yeast and mold count of different creameries. Butter received from larger creameries usually showed lower counts than that received from smaller plants. This is illustrated by the results presented in Table 13.

This table shows that the larger creameries of the group studied are more efficient than are the smaller ones in obtaining sanitation. There appears to be a direct relationship between the size of creamery

Table 12. Yeast and mold content of butter submitted for master buttermakers contest, 1937-38.

Rating	Range (Yeast and Mold per ml. Butter)	Number of Samples	Per Cent
Excellent.....	0 - 10	107	31.9
Good.....	11 - 50	72	21.5
Fair.....	51 - 100	29	8.6
Poor.....	101 - 500	71	21.2
Very Poor.....	Over 500	56	16.8

Table 13. Relation of the size of the creamery to the yeast and mold count of butter.

Creamery Size (Pounds per Year)	Average Yeast and Mold Count ml.
1,000,000 and over.....	52
500,000 and 1,000,000.....	102
300,000 to 500,000.....	154
100,000 to 300,000.....	265

and control of yeast and mold when the creameries are studied as groups.

Discussion and Summary

The quality of butter sent in for scoring in the Michigan Master Buttermakers Contest is representative of the day to day quality of butter manufactured by creameries entered in the contest. The reason for scoring the butter was principally to determine the ability of the buttermaker to score his own product, and there was nothing in the contest that would constitute a penalty for low-scoring butter. Consequently, it may be concluded that the butter received for this contest gives a good cross-section of the quality of butter manufactured in Michigan.

From the results obtained from analyzing the scores of butter it would appear that the average score of Michigan butter for 1937-38 ranged from 89.5 to 90. An apparent degree of quality difference in the butter is noticeable between creameries grouped for size of annual output. The larger creameries in the contest made the better quality butter. This may be accounted for by the fact that much of the output of the large creameries is sold on markets that demand certain high quality which is specified by contract. The small creameries, on the other hand, have less to sell and are situated where the local market will take more of the output. The large creameries may also employ better buttermaking technique and certainly are in a position to churn the cream into butter quicker following its purchase.

The ability of the buttermakers to score their own butter indicates that many of them lack this faculty. Only 16 were able to agree with the committee score by one point or less. It is essential that buttermakers train the sense of taste and smell to a higher degree. This enables them to locate sources of quality troubles.

Correct analysis of butter by the buttermaker is necessary in order to control butter composition. Such analysis is possible only when the instruments and solutions employed are correct, and when the proper care and technique are followed in sampling as well as in making tests. Fairly close agreement should exist between the analysis as obtained by the buttermaker and that obtained by some technically trained expert. The average agreement to within 0.75 per cent, as accomplished by 11 of the 38 contestants, should be obtained by more buttermakers. Incorrect analysis is certain to lead to excessive loss in overrun in some lots of butter, whereas in other lots will result in butter low in fat.

Controlling composition is of utmost importance in buttermaking. The composition of butter at the present is regulated by both State and Federal standard to contain not less than 80 per cent butter fat. If the buttermaker permits the fat content to exceed 80 per cent fat greatly, he loses his overrun and therefore his means of profit. The aim of the buttermaker should be to control the fat content within fairly safe limits. This usually can be done by observing the analysis values and making allowance for variations and errors.

The curd content of butter is one factor that is predictable. The results from this contest show the average curd content of the butter from 26, or 68 per cent, of the 38 contestants tested from 0.6 per cent to 0.8 per cent curd and only two of the buttermakers sent in samples averaging more than 1 per cent curd. The buttermaker should know his usual curd analysis and should make use of it in calculating for the amount of moisture to add for proper standardization. When careful operation of churning and analysis is employed, the buttermaker can usually obtain excellent control by allowing for a one per cent curd content in making calculations.

The control of moisture depends upon correct analysis of the fat present in the churning, obtaining proper samples, correct analysis of moisture in the first test, and proper calculations. A second test for moisture should be made to check on the results. The moisture control ability of buttermakers in this contest is illustrated by the fact that 12 contestants, or 31 per cent, differed on an average of 0.5 per cent or more than the standard desired, whereas 15 other contestants varied less than 0.3 per cent.

Salt content should be the most easily controlled of the butter constituents, since the buttermaker is able to weigh out the exact amount used in a churning. Differences will occur, however, due to uneven distribution of salt in some churns. Proper distribution can best be obtained by weighing salt into two lots and applying evenly in a trench. Leaky doors will permit brine to escape, and improper calculations will frequently cause salt variation. The creamery operator usually desires butter of uniform salt content, and from the variation in salt percentage indicated in the results of this contest, it is evident that many buttermakers need to follow more closely the rules prescribed for controlling the salt content. Four contestants had a salt variation of more than 2 per cent in the samples submitted, whereas only nine were able to hold the variation to less than 0.5 per cent.

The control of fat is a result of the control of moisture, salt, curd, and thorough analysis and correct sampling. From the data obtained in this contest, it is apparent that altogether too large a number of

samples had less than the legal amount of butterfat. Only 16 of the 38 contestants had 80 per cent fat and over in all the samples sent in for analysis. The average butterfat content of these samples was 80.8 per cent, compared with an average test of the entire lot of 80.5. The butter of less than 80 per cent tested but 79.13 per cent. It is, therefore, evident that the buttermakers running below 80 per cent fat in analysis are calculating for a fat standard closer to 80 per cent than they can safely control.

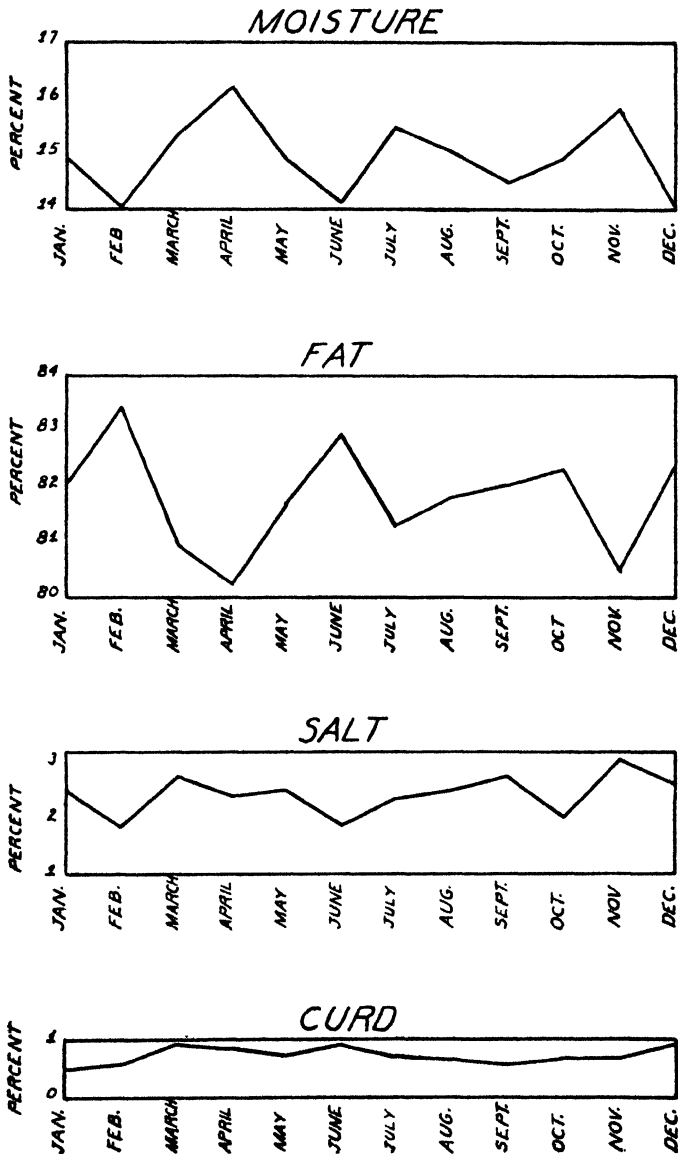


Fig. 1. Graphic illustration of poor moisture control in butter.

By studying the relationship of the size of the creamery to control of composition it appears that the larger creameries work on a more narrow fat margin than do the smaller ones.

For the buttermaker who is desirous of obtaining uniform composition control it is suggested that graphs be used to show the analyses of each churning manufactured. The influence of varying percentages of moisture, salt, and curd in butter is illustrated by Figs. 1, 2, and 3, which were plotted from one year composition records of three different contest entrants.

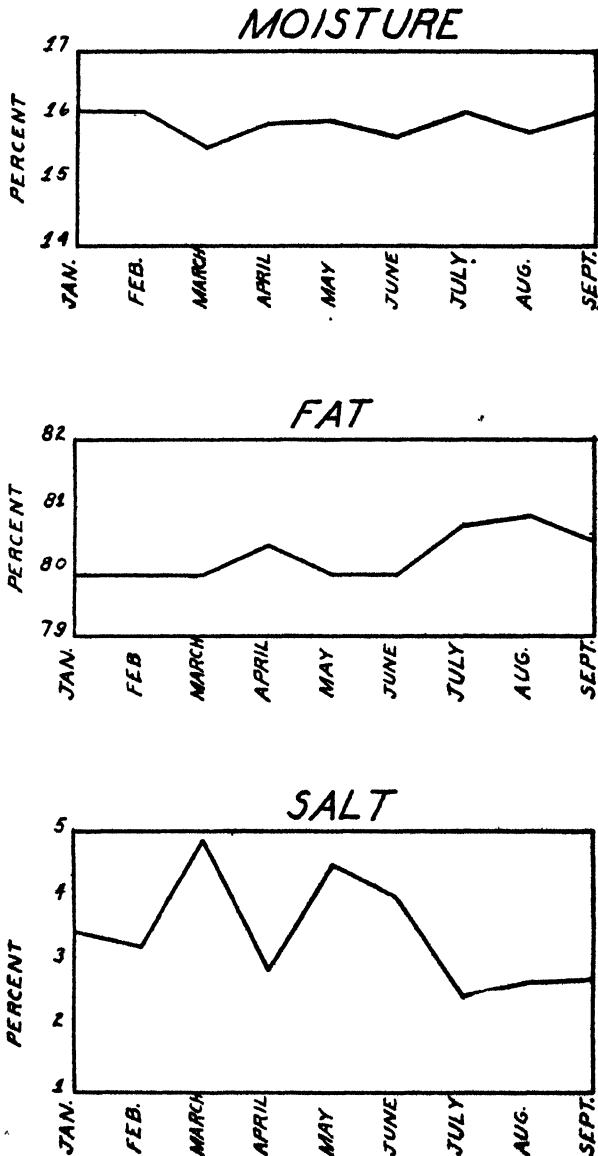


Fig. 2. Graphic illustration of poor salt control in butter.

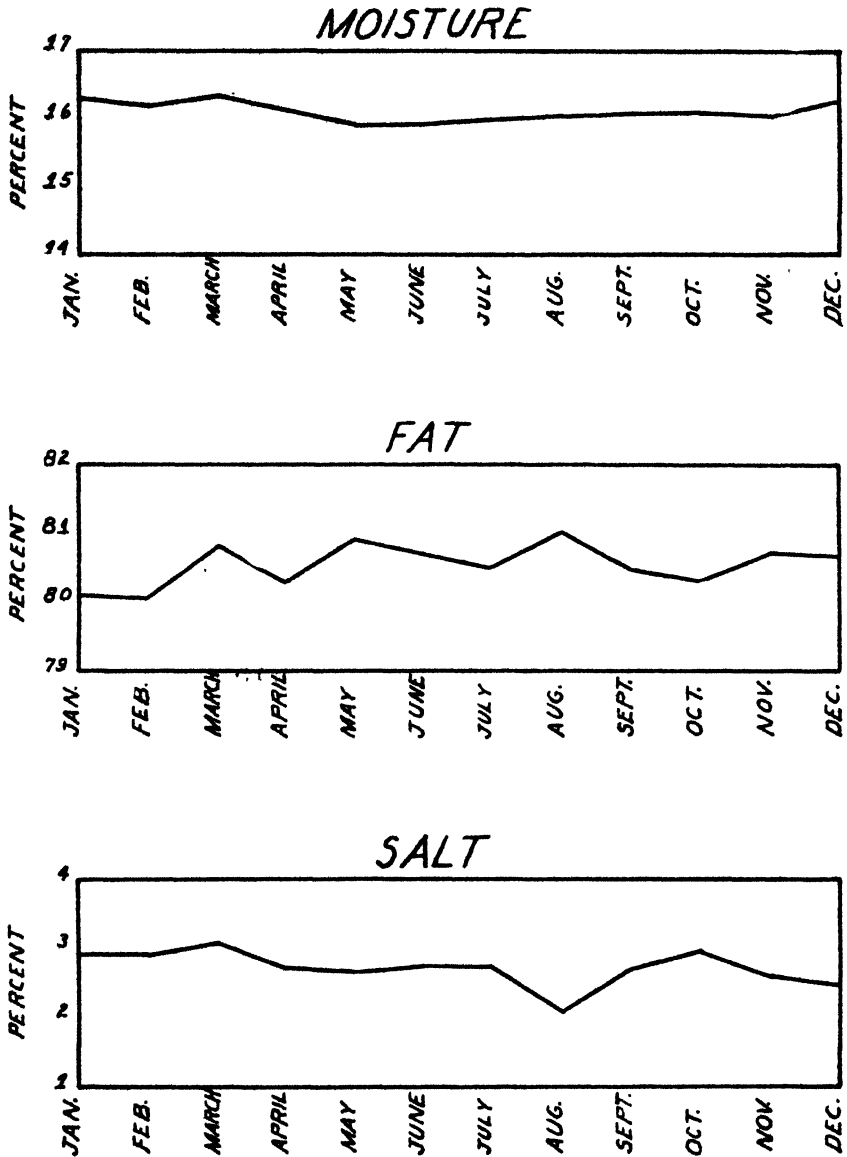


Fig. 3. Graphic illustration of good composition control in butter.

Figure 1 shows a decided lack of control of moisture with three samples near the 14 per cent line and one sample testing more than 16 per cent. The influence of the lack of moisture control is apparent in the fat content. When the moisture percentage was 14 in one instance, the butter tested 83.4 per cent fat. Such a fat loss on a 25-cent butter market is equivalent to more than a one cent loss per pound of butter.

The salt content of butter in Fig. 1 also shows lack of desirable uniformity, while the curd line is typical of most analyses in being quite uniform.

Figure 2 shows very poor salt control. The moisture control by this buttermaker was excellent, yet the fat content was below legal limits, owing to extremely high salt content in three different lots of butter. Figure 3 illustrates excellent moisture, fat, and salt control. The fat content in this chart varies between 80 and 81 per cent, which is considered ideal.

During later years, butter has been analyzed for yeast and mold count as a means of detecting faulty manufacturing procedure. High yeast and mold count is a measure of improper washing and sterilization of equipment used in making butter.

Of the samples examined during the period of this contest, 31.9 per cent were classed as "good". However, there were entirely too many with extremely high yeast and mold counts. The larger creameries showed better ability to control yeast and mold than did the small ones. The reason is apparently due to the more constant use of equipment, more skilled labor, and more decided effort to produce butter of low yeast and mold count.

LARVICIDES AND CONTACT SPRAYS USED IN MOSQUITO CONTROL

E. I. McDANIEL
SECTION OF ENTOMOLOGY

There are several reasons why mosquito control is side-stepped where possible. In the first place, to be 100 per cent effective, a mosquito campaign must be community-wide. It is desirable to recognize the species involved since each species varies from the others in habits and life history. It is necessary to locate and either treat or drain all breeding places before May 1 and to continue this campaign into September. The immature stages of all common mosquitoes require still water for their development. (Mosquitoes pass through four stages in their development; adult, egg, larvae and pupae—the last two stages are passed in water.) It is therefore apparent that any mosquito control program to be effective is centered around still water.

Each locality presents its own individual problem and while the same general principles apply they must be varied to meet local conditions. The drainage of stagnant pools, tiling to prevent the overflow of low lands in early spring, straightening of river banks to prevent pockets of still water along the banks, dredging streams or drainage ditches to create a current, or even opening up the banks of lakes so that the wind may roughen the surface are common practices in mosquito control.

There are conditions however where the foregoing suggestions do not seem desirable and under these conditions certain palliative measures have given a degree of relief which seems worthy of record.

Mosquito Larvae—Both the larval and pupal stages of mosquitoes can be killed with a pyrethrum emulsion made up according to the following specifications:

Stock formula:	LARGE QUANTITIES	SMALL QUANTITIES
Liquid soap (40% actual soap)	5 gallons	8 fluid oz.
Fuel oil or a high grade kerosene	95 gallons	2 gallons
Pyrethrum extract (20 fold)	5 gallons	7 ounces
Water	45 gallons	1 gallon

The fuel oil should fulfill the following specifications:

Specific gravity	32-37° Beaume
Flash	150 P F
Cold 0° F.	Pours
Boiling	350-675° F.
Straw colored	
Viscosity	50-100 Saybolt/100 sec.
Surface tension	20 dyns.

Pour the soap into the water and agitate until a heavy foam is formed. Combine the fuel oil with pyrethrum, then pour into the soap and water, agitate for at least 30 minutes. The result of this is a concentrated emulsion which mixes readily with water. The foregoing formula is a modification of that used in mosquito control work in Connecticut and New Jersey.

Dilute the stock emulsion, using 1 part stock emulsion in 12 parts water. Use at rate of about 25 gallons finished spray per acre.

The pyrethrum emulsion is better than oil on ornamental ponds. It does not kill fish nor spoil water plants. On pools with expensive plantings, reduce the amount of materials applied. On pools in woods, kerosene is safe—use at the rate of one-half ounce per 15 square feet.

If paris green is used, one-half pound per acre is sufficient—keep the dosage to the minimum. At this strength the water is not poisoned for higher animals nor is the foliage damaged.

Where one has woodland pools covered with green scum—a favorite breeding place for the malarial mosquito—copper sulphate is often recommended. This material kills the algae and the mosquito larvae starve. Only a small amount of copper sulphate is required; for that matter, bits of copper wire or empty cartridge shells may be used as a permanent source of copper in the pool after applying the copper sulphate for immediate results.

A film of kerosene, light fuel oil, or used crankcase oil thinned with kerosene on the surface of still water will kill mosquito larvae. However, under certain conditions, each of these materials has been found objectionable because of injury to vegetation, fish or water fowls, and unsightliness.

Adult Mosquitoes on Lawns or in Parks—Adult mosquitoes may be driven out of their daytime retreats and killed with any of the contact insecticides commonly recommended for the control of plant lice; of these the pyrethrum sprays have given the best results. The spray should be applied with a spray rig giving at least 200 pounds pressure. Spray the grass, and starting at the ground level spray trees and shrubs, using a fine mist spray, work gradually upward, finally shooting the

spray up 10 to 15 feet in the air and letting the spray drift beyond the bounds to be protected. (Use about 35 gallons to each 750 square feet.) Make the application a few hours before the gathering is to assemble. The length of time this spray is effective depends upon the source of infestation and weather—if the mosquitoes fly in, at least a week usually elapses before they again become a problem. However, if a crop is constantly hatching from a cistern, cesspool, or some neglected garden pool the infestation may build up in a shorter time.

When it is desirable to have on hand a stock emulsion, combine pyrethrum (flora grade) with a summer oil using 1 pound pyrethrum to 1 gallon of summer oil. Use 1 gallon of the stock solution to 100 gallons of water.

Nicotine fumigation is sometimes used to drive mosquitoes out of dense shrubbery about buildings, from around foundations or under porches. There are several brands of nicotine fumigators available and useful for this work. Start the fumigation before applying the spray. This insures having as many adults on wing at the time of the application as possible.

Electric exterminators around cottages, or in gardens not only have certain aesthetic values but where properly placed attract and kill a number of mosquitoes.

LEGUME SILAGE VS. CORN SILAGE VS. LEGUME HAY FOR FATTENING CATTLE

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One of the most interesting questions in connection with recent soil conservation programs, and the increased acreage of hay and pasture crops, has been the problem of curing and feeding of roughage crops. Unfavorable weather at harvest time has resulted in much low-quality hay of questionable feeding value. The silo has proved its value through the years for preserving the corn crop in a satisfactory manner; however, its use for storage of legumes has been alternately praised and berated. Recent methods, with the use of molasses, have been rather satisfactory as a means of storage. The question of feeding value has been little understood, and for that reason a group of steers was placed on experiment at the Michigan Station in the winter of 1938.

Plan and Procedure

The objects of the test were to compare in rations for fattening steers:

- a. Legume silage and legume hay,
- b. Legume silage and corn silage,
- c. Legume hay and corn silage.

It was thought that the simpler the rations, so long as they were well-balanced, the more direct the comparisons; also, the larger the

quantity of the feed to be studied, the greater would be the effect of that feed in the ration.

It has been demonstrated at this Station and elsewhere that acceptable steers for market may be produced by the full-feeding of well-eared corn silage, plus a protein supplement and hay. Since no data could be found indicating the amount of grain necessary to feed with hay for the production of cattle of "medium" to "good" grade, similar to those fed the corn silage ration, it seemed desirable to determine the minimum amount of grain necessary with a maximum amount of hay. A direct comparison between the legume silage and the hay was possible by feeding similar amounts of grain.

Rations fed were as follows:

Lot 1—Alfalfa-clover hay, full-fed; shelled corn sufficient to produce cattle gains similar to those in Lot 2; cottonseed meal the last 38 days.

Lot 2—Corn silage, full-fed; hay; cottonseed meal.

Lot 3—Alfalfa-clover silage, full-fed; shelled corn, and cottonseed meal, same amounts as in Lot 1.

Cattle of red and roan color, grading "medium" to "good" were purchased in Kansas City, Mo., early in December at \$7.50 per hundred pounds. Ten steers in each lot were started on feed December 23. They were fed 165 days, concluding the experiment June 6. Pigs in Lots 1 and 3 took care of undigested corn.

Hay was available at all times in Lots 1 and 2. Corn silage in Lot 2, and alfalfa-clover silage in Lot 3 were fed twice daily, in as large amounts as the steers could be induced to eat before the next feed.

Steers in Lot 2 were fed two and one-half pounds of cottonseed meal per day for each one thousand pounds of live weight. Shelled corn was fed twice daily in Lots 1 and 3. The steers in Lot 1 failed to equal those in Lot 2 in rate of gain despite increasing quantities of corn. One pound of cottonseed meal daily per steer was added in Lots 1 and 3 during the last 38 days.

The alfalfa-clover silage was made from a field of first-cutting alfalfa. There was considerable mixture with red clover, and a little sweet clover and timothy. It was cut during wet weather and put into a tile-block silo, while much of it was wet. A special hay cutter was used, with a pump attachment for regulating the flow of molasses according to the feed going into the cutter. Beet molasses was added at the rate of 60 pounds per ton of material. Some nutrients were apparently lost from the silo owing to leakage.

The hay was as nearly like the silage material as possible to obtain. It was of fair quality due to coarse growth and to rains when curing. Baling from the mow caused loss of some leaves.

Corn silage was in the glazing stage; and a test row gave the exceptionally high yield of 17.95 tons per acre, with each ton containing 3.13 bushels of shelled corn on a 15 per cent moisture basis. Another test row for mature corn yield was destroyed by squirrels and pheasants.

Not all chemical analyses of feeds have been completed as this report is being written, but one analysis is shown in Table 1. The two kinds of silage were approximately equal in dry matter content, while dry matter content of the hay was approximately 3.4 times as high as in either silage.

Table 1. Chemical analyses of feeds.

	Dry Matter	Crude Protein	Ether Extract	Carbohydrates		Ash	Calcium	Phosphorus
				Crude Fiber	N-free Extract			
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Legume hay	87.17	10.63	1.54	33.73	36.21	5.06	0.852	0.169
Legume silage	25.92	3.70	1.30	9.26	9.62	2.04	.280	.047
Corn silage	26.50	2.33	1.05	6.14	15.94	1.04	.078	.046

Comparative analyses are shown in Table 2 on a water-free basis. Corn silage was lowest in all nutrients except ether extract and nitrogen-free extract, which are the more digestible fattening nutrients. Legume silage was highest in protein, ash, and ether extract content, while the hay was highest in crude fiber.

Table 2. Analyses on water-free basis.

	Crude Protein	Ether Extract	Carbohydrates		Ash	Calcium	Phosphorus
			Crude Fiber	N-free Extract			
	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Legume hay	12.10	1.77	38.60	41.53	5.80	0.98	0.19
Legume silage	14.28	5.02	35.74	37.13	7.87	1.08	.181
Corn silage	8.78	3.95	23.15	60.09	3.92	.20	.17

Feeding Results

One pound of corn daily per hundred pounds of steer weight, together with legume hay full-fed, was not sufficient to produce as rapid gain as a full-feed of corn silage, supplemented with cottonseed meal and hay. Increasing the quantity of corn up to 1.5 pounds daily per hundred pounds of weight over a 10-week period was not enough to overtake the silage-fed cattle in weight and finish.

The addition of a pound of cottonseed meal daily per steer to the corn and hay ration during the last 38 days, resulted in more than double the rate of gain during the previous 28 days.

Table 3. Weights and gains of cattle.

December 23 1938-June 6 1939—165 days	Lot 1	Lot 2	Lot 3
	Alfalfa-Clover Hay	Corn Silage	Alfalfa-Clover Silage
Number of steers	10	10	10
Average initial weight	771.4 lbs.	768.9	770.4
Average final weight	1,081.1 lbs.	1,084.2	1,129.1
Average gain per steer	309.7 lbs.	315.3	358.7
Average daily gain	1.88 lbs.	1.91	2.17
Pig gains per steer	40.5		46.4

Table 4. Amounts of feed.

	Lot 1 Alfalfa-Clover Hay	Lot 2 Corn Silage	Lot 3 Alfalfa-Clover Silage
	(lb.)	(lb.)	(lb.)
PER STEER:			
Shelled corn	1,905		1,904
Cottonseed meal	38	369	38
Alfalfa-clover hay	2,112	244	.....
Alfalfa-clover silage .....	..		6,221
Corn silage .....	..	8,581	..
PER DAY:			
Shelled corn	11 54		11 54
Cottonseed meal (38 days in Lots 1 and 3)	1 00	2 24	1 00
Alfalfa-clover hay	12 80	1 48	37 7
Alfalfa-clover silage .....	..		..
Corn silage .....	..	52 00	..
PER CWT. GAIN:			
Shelled corn	615		531
Cottonseed meal	12	117	11
Alfalfa-clover hay	682	77	1,734
Alfalfa-clover silage .....	..		..
Corn silage .....	..	2,721	..

Estimated average shelled corn content in the daily feed of 52 pounds of corn silage was 5 pounds, as compared with 11.54 pounds of shelled corn eaten by the hay-fed cattle.

Pig gains amounting to 40.5 pounds per steer, or one-fourth pound daily per steer, were produced from the undigested corn in the hay-fed lot. No feed was available for pigs in the lot fed corn silage without additional corn.

Feedlot appraisals by market salesmen from Detroit, Buffalo, and Chicago averaged 5 cents higher per hundred pounds for the corn-silage-fed cattle, although opinions differed. Dressing percentages and carcass grades were similar, indicating room for difference of opinion.

If other feeds are charged at prices indicated in Table 5, with prices of cattle and of pig gains as indicated, and all other returns are

Table 5. Financial balance.

	Lot 1 Alfalfa-Clover Hay	Lot 2 Corn Silage	Lot 3 Alfalfa-Clover Silage
FLED COST PER STEER:			
Shelled corn at 56 cents	\$19 05		\$19.04
Cottonseed meal at \$30.00	57	\$5 54	57
Tankage to pigs at \$3.00	44		44
HAY AT \$7.81	8 25	.95	
LEGUME SILAGE AT \$4.74 .....	..	19 99	14 75
CORN SILAGE AT \$4.66 .....	..	26 48	34 80
Total Feed cost	28 31		
COSTS AND SALFS:			
Cost of steer on experiment at \$8.40	\$64 80	\$64.59	\$64 71
COST OF STEER AND FEED	93 11	91.07	99 51
Feed-lot appraisal June 9	8 35	8 40	8 52 1/2
Value of steer	90 27	91 07	96 26
Pig gains per steer at \$7.00	2 84		3 25
VALUE STEER AND PORK	93 11	91.07	99 51

credited to the hay or the corn silage, prices were realized of \$7.81 per ton for the hay and \$4.66 for the corn silage.

If corn is charged at 70 cents instead of 56 cents per bushel, the value of hay is reduced to \$3.30 per ton.

Comparing amounts of feed indicated in Table 4 for production of gain on the steers, a ton of silage and 77 pounds of cottonseed meal replaced 452 pounds or 8.1 bushels of corn, and 445 pounds of hay. In addition to the cattle gains, there were 9.44 pounds of pig gain from the above quantities of corn and hay in that lot of cattle.

Cattle fed alfalfa-clover silage and shelled corn made one-fourth pound per day more rapid, and also more consistent gain in weight than cattle in either of the other lots. Their gains increased, although not so markedly as the hay-fed cattle, when cottonseed meal was added to the ration during the last 38 days.

Pigs made slightly more gain from undigested corn than those in the hay-fed lot.

Feed-lot appraisals by market experts were 12.5 cents higher than the silage-fed cattle, or 17.5 cents higher than the hay-fed cattle, per hundred pounds. Individual opinions differed in regard to finish of these cattle; and despite 45 and 48 pounds, respectively, heavier average weight than was true in the other lots, dressing percentages and carcass grades were very similar.

If corn is charged at 56 cents per bushel, cottonseed meal at \$30 per ton, and cattle and hog prices are as shown in Table 5, crediting all other income to the legume silage allows a price for it of \$4.74 per ton. If beet molasses is worth \$14 per ton, the 60 pounds in a ton of silage is worth 42 cents, leaving a value of \$4.32 for the legume, itself.

If corn is charged at 70 cents instead of 56 cents per bushel, the value of the legume silage is reduced to \$3.21 per ton, instead of \$4.74. Deduction of 42 cents for molasses leaves \$2.79 per ton of legume.

Comparative chemical analyses indicate a pound of hay contains as much dry matter as 3.4 pounds of legume silage. It required only 2.9 times as much silage as of hay to satisfy the appetites of the steers and their daily gains were 0.25 pound faster.

Legume silage and corn silage were not interchangeable in the steer ration. Although steers fed legume silage made more rapid gain, and some pig gain was produced from corn in the droppings, they were receiving an average corn and cottonseed meal ration of 11.75 pounds daily, as compared with 2.24 pounds in the ration of steers fed corn silage.

Comparing amounts of feed for producing gain on the cattle, a ton

Table 6. Dressing percentages and market grades.

	Lot 1 Alfalfa-Clover Hay	Lot 2 Corn Silage	Lot 3 Alfalfa-Clover Silage
Market weight, cold carcass—per cent.....	57.1	57.7	57.6
Feed-lot weight, cold carcass—per cent.....	54.9	54.7	54.9
Carcass grades—No. of steers;.....			
Good.....	3	4	4
Medium.....	5	5	4
Common.....	2	1	2

of corn silage, plus 78 pounds of cottonseed meal and 57 pounds of hay, replaced 1,275 pounds of legume silage and 390 pounds, or 7 bushels of shelled corn. There was also produced from the latter feeds, 14.9 pounds of pork in addition to the cattle gains.

Summary

Results of this one experiment indicate that alfalfa-clover silage made with beet molasses is a more desirable feed for fattening steers than hay made from a similar crop.

More than one pound of grain per day per hundred pounds of steer weight must be added to a legume hay or a legume silage ration in order to produce gain and finish equivalent to that obtained when steers are full-fed well-eared corn silage and hay, balanced for protein with cottonseed meal.

In this experiment, the addition of a protein supplement to a ration of corn and legume hay or legume silage resulted in more rapid gain during the latter part of the feeding period.

BULLETIN REVIEWS

Tech. Bul. 163—Causes and Effects of Size Differences in Apple Trees in the Nursery.—Bradford, F. C. and Joley, L.—Seeds from a number of standard apple varieties such as Jonathan, Wealthy and Northern Spy, were found to yield seedlings of at least average size and vigor; those of certain other varieties, such as Baldwin, were found to produce weak seedlings. In general, seedlings of triploid varieties were weak and made poor rootstocks. Seedlings raised from seeds obtained from small apples of a given variety were, on the whole, just as large and vigorous as those raised from the seed of large apples of the same variety.

Though a number of exceptions were found, in general there was a marked tendency for the one-year-old trees grown on small weak seedlings to be considerably smaller than those grown on larger seedlings and, similarly, the larger size of the one-year-old budlings was reflected in a better growth the second year in the nursery. The evidence indicates that in general small seedlings should be discarded in the commercial propagation of apple trees. (54 pp., 27 tables, 8 figs.)

Tech. Bul. 164—Effect of Heat on Milk with Especial Reference to the Cooked Flavor.—Gould, I. A. Jr., and Sommer, H. H.—Studies were conducted to determine the influence of various factors upon the cooked flavor of milk, to ascertain the relationship of the cooked flavor to oxidation-reduction potentials and to oxidized flavor development, and to determine, if possible, the cause of the cooked flavor. Under the conditions of this experiment, the cooked flavor of milk occurred normally when the milk was heated momentarily to 76-78° C. This temperature was decreased with appreciable increases in the fat content, the pH, or the holding period, and upon addition of small quantities a sodium sulfite. The cooked flavor-temperature was slightly increased by homogenization of the milk prior to heating, by lowering the pH, and by addition of ferrous iron at the rate of 1.4 to 2.8 ppm. The temperature at which cooked flavor appeared was markedly raised by the addition of one ppm. of copper added to the milk before heating:

Decreases in the oxidation-reduction potentials were found to occur when milk was subjected to relatively high temperatures, this decrease being closely correlated with the appearance of the cooked flavor. In addition, the heat retardation and prevention of copper-induced oxidized flavor was found to be related to the cooked flavor, especially when the copper was added before the milk was heated. The critical temperature range in this connection was approximately 84-86° C. However, when the copper was added following the heat treatment, the cooked flavor quickly disappeared and the milk became oxidized, even though temperatures of 90° C. were used for processing the milk.

The liberation of sulphides from milk, probably as hydrogen sulphide, was found to be closely correlated with the appearance of the cooked flavor and the lowering of the oxidation-reduction potential. These

sulphides also served to explain the effect of heat on oxidized flavor development.

Efforts to utilize the nitroprusside test as a means of detecting sulphydryl groups in heated milk were unsuccessful. (48 pp., 19 tables, 6 figs.)

Tech. Bul. 165—Formulas for Finding Estimates for Two and Three Missing Plots in Randomized Block Layouts.—Baten, W. D.—Formulas are developed for estimating the yields of missing plots in experimental work and their use is explained. Of interest to those engaged in plot technique. (16 pp.)

Tech. Bul. 166—Studies of the Eastern Ruffed Grouse in Michigan.—Fisher, L. W.—Information is given on nesting habits, foods of young and adult birds, parasites, and factors influencing abundance. (46 pp., 12 tables, 9 figs.)

JOURNAL ARTICLE ABSTRACTS

Ascorbic Acid and Oxidized Flavor in Milk. I. Distribution of Ascorbic Acid and Occurrence of Oxidized Flavor in Commercial Grade A Raw, in Pasteurized Irradiated, and in Pasteurized Milk Throughout the Year.—Trout, G. M. and Gjessing, Erland C.—*Journal of Dairy Science* 22 (4): 271-281, 1939. [Journal Article 224 (n. s.) from the Mich. Agr. Exp. Sta.]—Samples of commercial grade A raw, irradiated pasteurized and regular pasteurized were titrated daily for four days for ascorbic acid by Sharp's 2-6 dichlorophenolindophenol direct titration method. On the third day of titration the milk was examined for development of oxidized flavor.

The ascorbic acid content of winter milk was lower than that of spring, summer, or fall, with summer milk usually having the highest ascorbic acid content. These average values for the year on first day of titration were 8.3, 10.9, and 12.2 mg. per liter for grade A, for pasteurized irradiated and for pasteurized milk, respectively.

The rate of disappearance of ascorbic acid, calculated on the third day, was greater in the winter than in the summer, being relatively greater in the irradiated and in the grade A milk than in the pasteurized milk.

The stored irradiated milk had a strong oxidized flavor from late fall to early spring. The grade A raw milk had a less pronounced oxidized flavor, whereas no oxidized flavor was noted in the pasteurized milk throughout the year.

The direct titration method of determining ascorbic acid in milk was helpful in predicting the presence of a catalyst in commercial bottled milk.

A Summary of Family Nomenclature in the Order Diptera.—Sambrosky, Curtis W.—*Verhand. VII. Int. Kongr. Ent.*, 1: 599-612, 1939. [Journal Article No. 299 (n. s.) from the Mich. Agr. Exp. Sta.]—Family names and basic nomenclature in the Diptera or two-winged flies are reviewed and criticized in this paper, which was presented before the Seventh International Congress of Entomology at Berlin, Germany, August 15-20, 1938. Because of conflicting usage and the resulting confusion in the family names commonly used by students and economic workers, a study was made of the principles involved in the selection of these names. A plea was entered for the adoption of a conservative viewpoint in harmony both with systematic entomology and with the needs of the practical field worker.

The Bovine Kidney in Health and Disease.—Langham, Robert and Hallman, E. T.—*Jour. Am. Vet. Med. Assoc.* 95: 22-32, 1939. [Journal Article No. 305 (n. s.) from the Mich. Agr. Exp. Sta.]—The authors discuss the result of their studies of the microscopic anatomy of the cow's kidney. This is followed by a discussion of the generally accepted theory of urinary function.

The portion of the article dealing with disease is based on a study of the kidneys from 24 animals from the Dairy Section Experimental herd that had been maintained on low magnesium diets. Extensive changes involving the tubules, the intertubular connective tissue and the arteries are described and illustrated.

Effect of Prontosil and Sulfanilamide on *Brucella Abortus* Infection in Two Cows.—Hamann, E. E. and Huddleson, I. F.—*Jour. Am. Vet. Med. Assoc.* 47 (n. s.) (1): 35. 1939. [Journal Article No. 311 (n. s.) from the Mich. Agr. Exp. Sta.]—Prontosil was administered subcutaneously and intravenously, and sulfanilamide orally, to two cows infected with *Br. abortus*. The administration of the two agents failed to reduce the number of *Br. abortus* organisms eliminated in the milk from the animals.

Pathology of Calf Pneumonia.—Thorp, W. T. S. and Hallman, E. T.—*Jour. Am. Vet. Med. Assoc.* 47 (4): 365-371. 1939. [Journal Article No. 323 (n. s.) from the Mich. Agr. Exp. Sta.]—This paper is based on a pathological study of 40 cases of calf pneumonia, 26 of which were also studied bacteriologically. Three variations were noted in the pathology of these cases: (1) an acute pneumonia, which progresses very rapidly, with the animal dying within several days, without evidence of any productive tissue changes but usually with a serofibrinous exudate filling the alveoli; (2) an acute pneumonia superimposed on a chronic bronchiolitis or chronic bronchopneumonia in which a large part of both lungs is consolidated accompanied by a marked fibrinous pleurisy, and (3) the cases in which large numbers of abscesses and necrotic areas are present in the lung. The pneumonia was consistently bilateral.

The gross and microscopic studies indicate that the pneumonia usually begins in the apical lobes and that it is consistently of longer duration in the left lung than in the right.

Evidence in a large number of cases suggests that accompanying injury to the respiratory bronchioles is prior to a bronchitis of the small and large bronchi. Streptococci of the Beta type and *Escherichia communior* were found to a variable extent and were considered as probable causative agents.

Patterns Based Upon the Distribution of Swamp Land in Michigan.—Veatch, J. O.—Michigan Academy of Science, Arts and Letters. 24 (3): 93-106. 1938. Published in 1939. [Journal Article No. 325 (n. s.) from the Mich. Agr. Exp. Sta.]—Michigan includes a vast acreage of wet or swamp land. This is widely distributed and the separate bodies vary greatly in size, shape, and origin. In this article an attempt is made to classify the wet land mainly on the basis of the shape, size, and association of the separate bodies. Twelve illustrative sketch maps, or patterns of swamp land, are presented. Since swamps are an important element of the natural landscape in Michigan, their classification should have special significance in relation to land classification and to problems of land use and land planning.

A Preliminary Report of the Blood Picture of Brucellosis.—Munger, M. and I. F. Huddleson.—*Jour. Lab. and Clinical Med.* 24 (6): 617-619. 1939. [Journal Article No. 333 (n. s.) from the Mich. Agr. Exp. Sta.]—

A study of the blood picture in 32 cases of *Br. melitensis* infection in humans revealed a leucopenia with a relative lymphocytosis and monocytosis.

The red blood cells tend to be slightly smaller than normal; however, some patients gave evidence of macrocytosis.

The presence of "pathologic lymphocytes" in 40 per cent of the brucellosis cases is significant. "Liver damage cells" were found consistently in these patients. Finally the basophilia of the granules of the neutrophils seem to differentiate the *Brucella melitensis* infection from that of the *suus* and *abortus* infection.

Effect of Organic Matter on the Water-Holding Capacity and the Wilting Point of Mineral Soils.—Bouyoucos, G. J.—Soil Science 47: 377-383. 1939. [Journal Article No. 336 (n.s.) from the Mich. Agr. Exp. Sta.]—An investigation was conducted to ascertain the effect of organic matter on the water-holding capacity and wilting point of soils, different organic materials and various types of mineral soils being used.

The experimental results obtained show that, when expressed on the percentage basis, organic matter increases markedly the available water in light soils, and to a less extent that in heavy soils. This is true whether the computation is based on the weight basis or the volume basis.

A Method by Which Trees May be Grown with Their Roots in Two Soils.—Partridge, N. L.—Proc. Am. Soc. Hort. Sci. 36: 77-80. 1939. [Journal Article No. 337 (n.s.) from the Mich. Agr. Exp. Sta.]—A description is given of paired boxes of galvanized iron in which dwarf apple trees were grown. The trees were set on the dividing partition with approximately half of the roots in each box of the pair. The soil, moisture supply and nutrient supply available to the two portions of the root system could then be varied. The experimental results in this test show that the trees, grown with an abundant supply of nitrogen, had stored enough so that no nitrogen deficiency became apparent during one growing season when further supplies were not given during the summer. During the second growing season such deficiencies were apparent on those trees or portions of trees which received no further supplies.

A Microtitration Method for Determining the Readily Soluble Boron in Soils.—Cook, R. L. and Millar, C. E.—Soil Science Society of America Proc. 3: 146-152. 1938. [Journal Article No. 340 (n.s.) from the Mich. Agr. Exp. Sta.]—A method for determining dilute-acid-soluble or "available" boron was developed for use in connection with studies of boron deficiency symptoms and as an aid in recommending the use of borax on boron-deficient soils. The method as finally designed may be outlined as follows:

Extract the boron from a 100 grm. sample of soil with 100 ml. of boiling H_2SO_4 of sufficient strength to dissolve carbonates and leave the solution acid. (N/50 H_2SO_4 for samples free of carbonates is advised.) Make the extract alkaline with Na_2CO_3 and evaporate to dryness. Take up the residue with H_2SO_4 and MeOH and distill as MeBO_3 into water made alkaline with Na_2CO_3 . Add one drop rosolic acid, evaporate to a small volume, make acid with HCl and expell the CO_2 by heating.

Adjust the pH to approximately 7.5 with N/10 HCl or NaOH. Add sufficient mannitol to dissociate the boric acid and titrate with N/100 NaOH.

Tests made with greenhouse and field soils showed the lower limit of sensitivity of the test to be approximately 0.025 mg. B_2O_3 .

To establish the reliability of the method, a large number of tests were made. Borax was applied to greenhouse pot cultures at rates ranging from 25 to 2000 pounds per acre. From later samplings, it was possible to account for most of the applied boron. Likewise, broadcast applications of borax ranging from 10 to 80 pounds per acre on field plats were readily detected and could be quite accurately measured by means of soil tests.

Tests were also made to show that the method could be used in detecting the presence of B_2O_3 in leachates from pot cultures. It was suggested that the method be used in a study of boron fixation or availability.

Studies of An Atypical Strain of *Brucella Abortus* Isolated from a Naturally Infected Animal.—Hamann, E. E. and Huddleson, I. F.—Veterinary Medicine, 34 (4): 232. 1939. [Journal Article No. 341 (n. s.) from the Mich. Agr. Exp. Sta.]—A strain of *Br. abortus* was isolated from the milk of an animal in a herd of cattle which was pathogenic for guinea pigs, but failed to produce a positive agglutination reaction to any extent.

During a two-year period an attempt was made to eradicate Bang's disease from the herd by removing reacting animals. New reactors were found on each subsequent test at intervals of three months. Since removal of reactors failed to control the disease over a period of two years, vaccination of the remaining negative animals was attempted. Vaccination failed to control the progress of the infection.

Effect of Certain Mineral Elements on Some Microbiological Activities in Muck Soils.—Turk, L. M.—Soil Sci. 40: 425-445. 1939. [Journal Article No. 343 (n. s.) from the Mich. Agr. Exp. Sta.]—Materials such as $CuSO_4$, NaCl, $MnSO_4$, sulphur, boron, nitrogen, lime, phosphorus, and potassium were added to muck soils in the laboratory and studies made concerning their effect on ammonification, nitrification, CO_2 production, and changes in numbers of bacteria and fungi. Nitrate accumulation was increased by addition of lime to acid soils. Phosphorus and potassium additions produced small increases in nitrates on both limed and unlimed soils. Nitrogen, in addition to phosphorus and potassium, produced consistent increases in nitrates only on the limed soils. For the most part, $CuSO_4$ showed a retarding rather than a stimulating effect on ammonia and nitrate accumulation. Sodium chloride with lime decreased nitrates and in some cases where lime was not used. Manganese sulphate had neither a pronounced stimulating nor a retarding effect on either the ammonifiers or the nitrifiers. Iron sulphate stimulated nitrification but no appreciable effect was noted from the use of KI, $BaCl_2$, Al_2SO_4 , $ZnSO_4$, H_3BO_4 , Na_2SO_4 , or a manure infusion. Sulphur stimulated nitrification on alkaline mucks. None of the treatments was effective in increasing CO_2 production unless mannitol was also added. The production of CO_2 was retarded by the addition of NaCl. Increases in numbers of bacteria and fungi were

obtained when either CuSO_4 or NaCl was used with either the 0-8-24 or 3-8-24 fertilizer.

Relationship Between Carotene, Blindness Due to Constriction of the Optic Nerve, Papillary Edema and Nyctalopia in Calves.—Moore, I. A.—*Jour. Nutrition*. 17 (5): 443-459. 1939. [Journal Article No. 346 (n. s.) from the Mich. Agr. Exp. Sta.]—For the past 20 years various investigators have noted a peculiar type of blindness in calves associated with rations where poor quality or no roughage was fed. Previous work has shown that the blindness is due to a constriction of the optic nerve where it passes through the optic foramen caused by a stenosis of the bony canal. Further work with calves has shown that the blindness is preceded by nyctalopia and ophthalmoscopic observations revealed papillary edema and bleaching of the Tapetum Lucidum. Holstein calves placed on the blindness-producing ration and fed crystalline carotene dissolved in cottonseed oil in quantities sufficient to keep the blood plasma carotene level well above a lower limit of 0.13 micrograms per ml. did not develop these eye changes. Vitamin A deficiency is therefore the causative factor.

In mature cows nyctalopia and papillary edema develop but blindness due to constriction of the optic nerve does not develop because the bony optic canal has already been formed. In calves blindness due to constriction of the optic nerve and papillary edema are associated while nyctalopia is a separate process but due to the same deficiency.

Papillary edema is a cardinal sign of increased intracranial pressure. Vitamin A may therefore be necessary for the regulation of this pressure. Increased intracranial pressure may also account for certain nervous manifestations of vitamin A deficiency.

Response of Certain Perennial Grasses to Cutting Treatments.—Harrison, C. M. and Hodgson, C. W.—*Jour. Am. Soc. Agron.* 31 (5) 418-430. 1939. [Journal Article No. 347 (n. s.) from the Mich. Agr. Exp. Sta.]—Orchard grass (*Dactylis glomerata* L.), timothy (*Phleum pratense*), quack grass (*Agropyron repens*), Kentucky bluegrass (*Poa pratensis*), smooth brome grass (*Bromus inermis*), and a mixture of smooth brome grass and alfalfa were grown in sand culture in the greenhouse and cut weekly at three different heights for eight successive weeks between March 30 and May 26. In general, the shorter a given species was cut, the less total top growth and underground parts it produced. The various species rated in the following order as regards resistance to injury sustained by frequent close clipping: Kentucky bluegrass, quack grass, smooth brome grass with timothy and orchard grass being about equal. Smooth brome grass made better growth when grown in association with alfalfa than when grown alone.

Induced Parthenocarp of Watermelon, Cucumber and Pepper by the Use of Growth Promoting Substances.—Wong, C. Y.—*Proc. Am. Soc. Hort. Sci.* 36: 632-636. 1939. [Journal Article No. 349 (n. s.) from the Mich. Agr. Exp. Sta.]—In experiments conducted in 1938 parthenocarpic development of fruits of the cucumber, watermelon and pepper were obtained by treating either stigmas or cut styles with naphthalene acetic acid (in concentrations of 1 to 5 per cent in lanolin paste). Parthenocarp was also induced by spraying a 0.05 per cent solution of naphthalene acetic acid on the stigmatic surfaces. The resulting fruits were

seedless but of normal season of maturity, texture and flavor. In some instances, they were somewhat smaller in size and less regular in shape, though in other instances their exterior appearance was like that of normal seed-bearing specimens.

The European Frit Fly and Its Forms in North America.—Sabrosky, C. W.—*Annals Ent. Soc. Amer.* 32: 321-324. 1939. [Journal Article No. 351 (n. s.) from the Mich. Agr. Exp. Sta.]—The European frit fly, an important pest of grains in Europe has been widely reported in North America, although not causing as much damage here. A new classification is now proposed for this species and its relatives, wherein three species and one variety are accepted instead of the one widely varying species hitherto recognized.

Experimental Work on Processing and Finishing Pickles. I. Rate of Diffusion of Salt from Pickles During the Freshening Process.—Switzer, R. G., Richardson, D. E. and Fabian, F. W.—*Fruit Products Jour.* 18 (9): 260-261, 281, 283. 1939. [Journal Article No. 364 (n. s.) from the Mich. Agr. Exp. Sta.]—A study was made of the best method of freshening pickles prior to processing them. Some manufacturers are not cognizant of the fact that after the salt is withdrawn from the pickle during the freshening process spoilage soon takes place. It was found that:

1. For maximum efficiency, salt stock pickles should be freshened at 70° F. or above.
2. Eight-hour freshening periods are recommended, since about 95 per cent of the salt which is capable of being removed in 12 hours has diffused out in the first 8 hours.
3. When circumstances warrant, salt stock pickles may be completely freshened in about 8 to 10 hours by circulating fresh water through the tank at a moderate rate.

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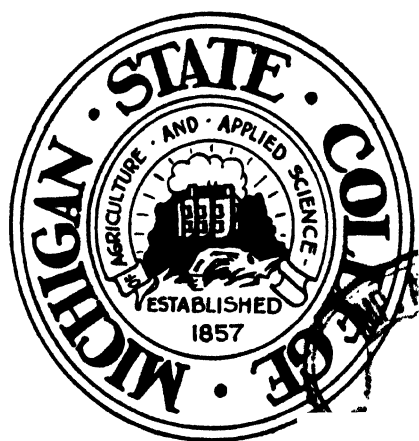
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**EDITED BY
V. R. GARDNER AND A. A. APPLIGATE**

**CONTRIBUTIONS BY ALL SECTIONS OF THE
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TRACTION TESTS OF SINGLE PNEUMATIC TIRES VERSUS DUAL PNEUMATIC TIRES

E. C. SAUVE

AGRICULTURAL ENGINEERING SECTION

Pneumatic tires for tractor use were first introduced into Michigan during the spring of 1933. The years following the advent of these pneumatic tires have definitely proved the soundness of this wheel equipment to the extent that a very high percentage of new farm tractors are being equipped with pneumatic tires. It was recognized that the first pneumatics were criticized as to their inability to operate under all conditions for which the spade lug steel wheel tractors were successfully operating. If pneumatic tires were to supplant the conventional equipment of steel wheel with spade lugs, it became necessary to give some thought to lug design for these pneumatics.

The rubber fabricating companies began research work along this line with the result that various treads were designed in an attempt to improve tractor traction on a variety of soils and under different soil conditions.

The fact that farmers are using pneumatic-tired tractors in rapidly increasing numbers would indicate an acceptance of the improvements made in lug design.

Introduction of Dual Pneumatics

Within the last year keen interest was manifested in the use of dual pneumatic tires in the hope that traction would be improved over the single pneumatic. Some previous work had been done in which an additional tire was used with each drive member. Tests proved that duals of this kind were advantageous in improving traction, particularly in muck soil. The cost of such dual equipment, however, was approximately twice that of the single pneumatics.

Then came the development of small cross-section tires to be used in dual combination. The cost of two of these new tires in dual combination was intended to be more nearly the cost of the single pneumatic.

A problem immediately arose as to the relative tractive efficiency of these new small section duals as compared to the single pneumatic. The material which follows deals with tests conducted in an attempt to clarify this problem.

Location of Tests

The tests were conducted on the Livingston farm, about two and one-half miles north of St. Johns, Mich.

Materials and Method

A new 2-row cultivating type tractor was employed for the test, obtained through a local dealer. The dynamometer test truck and tires were supplied by the Goodyear Tire and Rubber Company of Akron, Ohio.*

Conditions and Limitations of Tests

Tests were conducted on three soil types—namely, silty loam, sand, and muck. The condition of the soils was highly favorable to good traction and low slippage because the soil was dry. The results and conclusions of this report do not necessarily apply to soils with higher moisture content; particularly is this true of muck soils.



Fig. 1. The truck dynamometer and tractor with 5.00-44 dual pneumatics.

The six conditions under which tests were conducted were as follows:

1. Timothy sod

- (a) 9.00-36 singles versus 5.00-44 duals with weight on each drive wheel 1525 pounds. See Table 4.
- (b) 9.00-36 singles with 1797 pounds on each drive wheel versus 9.00-36 singles with 1525 pounds on each drive wheel (Table 5).

2. Sand (Oat stubble)

- (a) 5.00-44 duals (1525 pounds on each wheel) versus 5.00-44 duals (1797 pounds on each wheel) (Table 8).
- (b) 9.00-36 singles (1797 pounds on each wheel) versus 9.00-36 singles (1525 pounds on each wheel) See Tables 9 and 10.

*Acknowledgment is given to E. F. Brunner of the Goodyear Tire and Rubber Company for making the test possible and to L. H. Skromme and H. G. Coburn who acted as engineers during the tests.

3. Muck (Mint stubble)

- (a) 5.00-44 duals (1525 pounds per wheel) versus 9.00-36 singles (1525 pounds per wheel) See Table 2.
- (b) 9.00-36 singles (1797 pounds per wheel) versus 5.00-44 duals (1797 pounds per wheel) See Table 3.

4. Muck (Plowed and rolled)

- (a) 9.00-36 singles (1525 pounds per wheel) versus 5.00-44 duals (1525 pounds per wheel) See Table 1.

5. Freshly plowed and disked ground (silty loam)

- (a) 9.00-36 singles (1797 pounds per wheel) versus 5.00-44 duals (1797 pounds per wheel) See Table 10.

6. Freshly plowed ground (silty loam)

- (a) 9.00-36 singles (1797 pounds per wheel) versus 9.00-36 singles (1525 pounds per wheel) See Table 6.
- (b) 9.00-36 singles (1525 pounds per wheel) versus 5.00-44 duals (1525 pounds per wheel) See Table 7.

An additional test was performed to show the effect of tractor ground speed and slip for one soil condition—namely, timothy sod.

Table 1. Tractor performance in muck soil of singles versus duals—1525 pounds on each wheel.

	9.00-36 Singles—1525 lb.				5.00-44 Duals—1525 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	555	0	1.9	2.80	645	0	1.85	3.18
Push	560	0	1.83	2.70	672	0	1.88	3.36
Push	650	0	1.66	1.66	735	0	1.80	3.53
Pull	290	6.8	2.38	1.84	250	8.6	2.36	1.57
Pull	410	9.0	2.31	2.50	400	10.2	2.32	2.48
Pull	590	11.1	2.26	3.56	580	13.4	2.25	3.48
Pull	740	14.0	2.18	4.30	720	15.4	2.18	4.18
Pull	890	18.8	2.04	4.84	780	19.7	2.06	4.28
Pull	1000	22.6	1.94	5.17	910	25.5	1.92	4.66
Pull	1040	29.2	1.77	4.9	920	63.8	0.91	2.23
Pull	1140	39.5	1.50	4.56	1000	39.1	1.55	4.14
Pull	1230	63.7	0.90	2.95	1000	65.5	0.83	2.22

Table 1 and Graph No. 1 indicate a superiority of the single pneumatic over the dual pneumatic as they relate to drawbar pull and slip in muck soil which was plowed and rolled.

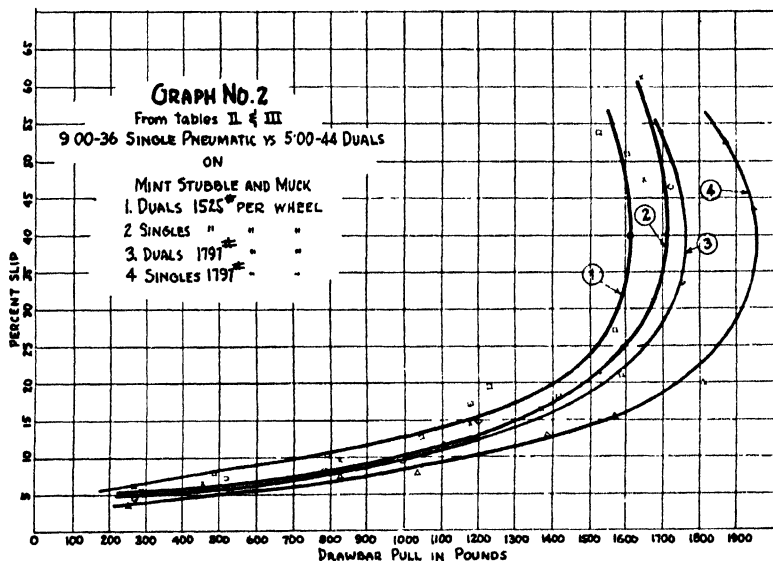
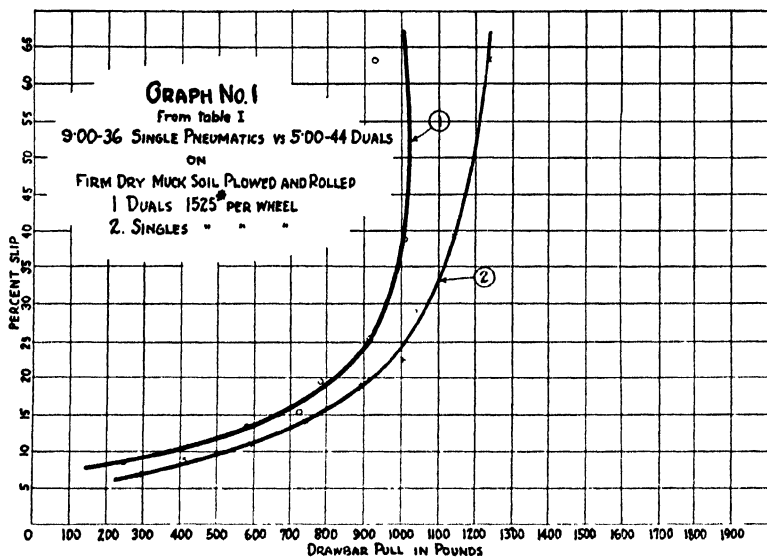


Table 2. Tractor performance in dry muck (mint stubble) of duals versus singles—1525 pounds on each wheel.

	5.00-44 Duals—1525 lb.				9.00-36 Singles—1525 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	408	0	2 58	2 81	420	0	2.81	3.15
Push	450	0	2.50	3 00	438	0	2.20	2 57
Push	388	0	2.73	2 83	385	0	2.36	2.32
Pull	270	5.13	3 28	2 36	290	5 7	3 21	2.48
Pull	490	8 10	3 19	4.17	460	6.87	3.16	3 88
Pull	800	10 70	3.04	6 49	830	9.76	3.03	6 70
Pull	1050	13.00	2.97	8 32	1040	10 5	3.02	8.38
Pull	1180	17 50	2 81	8.84	1180	14.9	2.85	8 98
Pull	1230	19.80	2 71	8 90	1370	16 65	2.76	10 08
Pull	1420	18 50	2 75	10 42	1530	21.7	2 59	10.55
Pull	1530	54 4	1 46	5 97	1640	61 2	1.24	5.43
Pull	1570	27.4	2 45	10 25	1650	47 6	1 71	7.52
Pull	1600	51 3	1 58	6.74	1680	38 4	2.03	9.10

Table 2 and Curves 1 and 2 of Graph No. 2 show clearly the advantage of single pneumatics over the duals in muck (mint stubble) as they relate to drawbar pull and slip.

Table 3. Tractor performance in dry muck (mint stubble) of singles versus duals—1797 pounds on each wheel.

	9 00-36 Singles—1797 lb.				5 00-44 Duals—1797 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	453	0	2.59	3 13	485	0	2 52	3 26
Push	488	0	2 52	3 28	517	0	2 63	3 62
Push	420	0	2.64	2 96	455	0	2.67	3.24
Pull	260	3.89	3 19	2 22	280	4 63	3 28	2.45
Pull	530	5 47	3 14	4 44	520	7 28	3 18	4.41
Pull	830	8.00	3 06	6 77	790	8 38	3 14	6 61
Pull	1040	8 83	3 02	8 38	1000	9 8	3 05	8.13
Pull	1110	11.83	3 01	8 92	1200	15 0	2 86	9 17
Pull	1390	13.4	2 90	10 75	1590	21 4	2 63	11 15
Pull	1570	15.9	2 77	11 6	1750	33 9	2 08	9.71
Pull	1810	20 5	2 57	12.5	1720	46 7	1.49	6.84
Pull	1950	43.8	1 61	8 38	1700	54 4	1 20	5.44

Table 3 and Curves 3 and 4 from Graph No. 2 show the advantage of single pneumatics over the duals in muck (mint stubble) as they relate to drawbar pull and slip when 1797 pounds weight was on each drive wheel. Additional conclusions may be drawn from a study of all curves on Graph Sheet No. 2.

Table 4. Tractor performance in timothy sod (silty loam soil) comparing duals versus singles with 1525 pounds on each wheel.

	5.00-44 Duals—1525 lb.				9.00-36 Singles—1525 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	310	0	2 51	2 07	290	0	2 67	2.06
Push	293	0	2 36	1 845	255	0	2 41	1 64
Push	240	0	2 49	1.59	298	0	2 30	1.83
Pull	360	3.15	3 33	3 20	380	3.63	3 25	3 29
Pull	680	5.53	3 25	5 90	800	5 18	3 16	6.74
Pull	1120	8.48	3 12	9 33	1100	7 98	3 09	9.07
Pull	1420	11.5	2 82	10 68	1440	10 55	2 96	11.35
Pull	1680	16.4	2 81	12.60	1600	12.65	2 91	12 40
Pull	2000	23.55	2 54	13 57	1910	16.80	2 71	13.80
Pull	2220	33 95	2 015	11.92	2240	23.6	2 37	14 15
Pull	2350	35 10	1 34	8.37	2480	28 2	1 66	10 96
Pull	2610	52 8	1 15	8 02	2750	49.2	1 21	8.88

Table 4 and Curves 1 and 2 from Graph No. 3 show the advantage of single pneumatics over the duals on timothy sod as they relate to drawbar pull and slip when 1525 pounds weight was on each wheel.

Table 5. Tractor performance in timothy sod (silty loam soil) comparing singles with 1525 pounds on each wheel versus singles with 1797 pounds on each wheel.

	9 00-36 Singles—1525 lb.				9 00-36 Singles—1797 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	290	0	2 67	2.06	328	0	2 67	2 34
Push	255	0	2 41	1 64	310	0	2 54	2.10
Push	298	0	2 30	1.83	—	—	—	—
Pull	380	3 63	3 25	3 29	420	2 94	3 22	3.61
Pull	800	5 18	3 16	6 74	820	4 30	3 14	6 86
Pull	1100	7 98	3 09	9 07	1150	6 51	3 02	9 28
Pull	1440	10 55	2 96	11 35	1590	8 49	2 98	12 63
Pull	1600	12 65	2 91	12.40	1750	11 02	2 91	13 58
Pull	1910	16 80	2 71	13 80	2050	14 80	2 74	14 98
Pull	2240	23 60	2 37	14 15	2400	17 30	2 39	15.30
Pull	2480	28 20	1 66	10 96	2810	24 90	1 79	13.40
Pull	2750	49.2	1.21	8 88	3220	40 3	1 29	11.07
	—	—	—	—	3310	49 2	0 99	8 74
	—	—	—	—	3170	53 4	1 025	8 65

Table 5 and Curves 2 and 3 from Graph No. 3 show a traction advantage of single pneumatics with 1797 pounds weight per wheel as compared with single pneumatics with 1525 pounds weight per wheel in timothy sod.

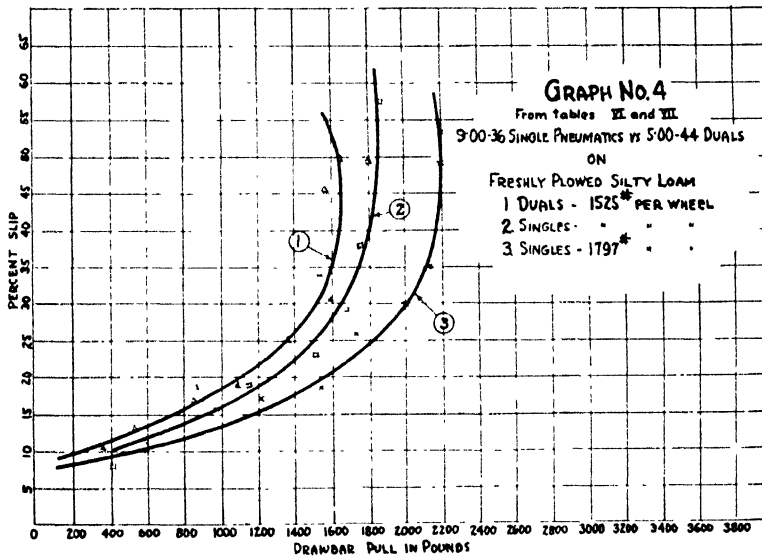
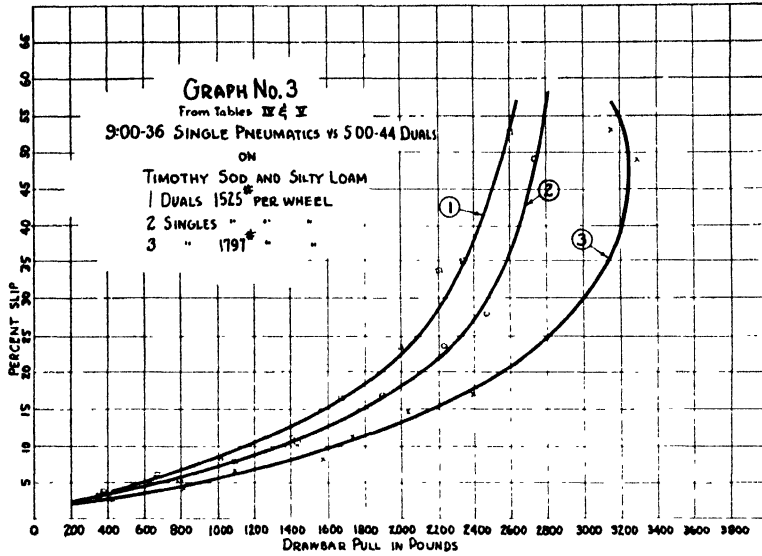


Table 6. Tractor performance in freshly plowed ground (silty loam soil) comparing singles with 1797 pounds on each wheel with singles with 1525 pounds on each wheel.

	9 00-36 Singles—1797 lb.				9.00-36 Singles—1525 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	985	0	1 95	5.12	*978	0	1.77	4.62
Push	960	0	1 92	4.92	*963	0	2 07	5.32
Pull	450	9 7	3.16	3.79	440	8 42	3.28	3 85
Pull	630	11 3	3 12	5.25	880	17.15	2.94	6 90
Pull	1000	15 9	2 93	7.82	1180	19 4	2 83	8 92
Pull	1250	16 25	2 89	9 64	1540	23.3	2.64	10 83
Pull	1580	18 9	2 70	11 38	1710	29 6	2 42	11 04
Pull	1770	26 05	2 46	11 63	1790	37 9	1.82	8.69
Pull	2030	30 2	1 914	10 38	1840	49 7	1 47	7 30
Pull	2170	35 3	1 655	9 58	1900	57 5	1 09	5 53
Pull	2220	49 2	1 28	7 56	—	—	—	—
Pull	2230	53 3	1 105	6.58	—	—	—	—

*The traction dial needle in these tests was discovered to be incorrect causing the push tests, indicating rolling resistance, to be too high.

Table 6 and Curves 2 and 3 from Graph No. 4 show a traction advantage of single pneumatics with 1797 pounds weight on each wheel over the singles with 1525 pounds weight on each wheel in freshly plowed ground.

Table 7. Tractor performance in freshly plowed ground (silty loam soil) comparing single pneumatics with 1525 pounds on each wheel with dual pneumatics with 1525 pounds on each wheel.

	9 00-36 Singles—1525 lb				5.00-44 Duals—1525 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	*978	0	1 77	4.62	823	0	2.04	4.48
Push	*963	0	2 07	5 32	855	0	2 07	4 72
Pull	440	8.42	3.28	3.85	390	10.95	3.18	3 31
Pull	880	17.15	2 94	6.90	570	13.25	3.12	4 74
Pull	1180	19 4	2 83	8.92	900	18.90	2.88	6.92
Pull	1540	23 3	2.64	10 82	1120	19.1	2.87	8 59
Pull	1710	29 6	2.42	11 04	1390	25 2	2.64	9 79
Pull	1790	37 9	1 82	8.69	1630	30.7	2.35	10 22
Pull	1840	49 7	1 47	7 30	1570	34.3	1.89	7.82
Pull	1900	57.5	1 09	5.53	1600	45.6	1.68	7.18
	—	—	—	—	1680	49 8	1.30	5.83

*The traction dial needle in these tests was discovered to be incorrect causing the push tests, indicating rolling resistance to be too high.

Table 7 and Curves 1 and 2 from Graph No. 4 show a traction advantage of single pneumatics over dual pneumatics in freshly plowed ground when the tires carried the same weight of 1525 pounds on each wheel.

Table 8. Tractor performance in sandy soil (oat stubble) comparing duals with duals to show the effect of traction as weight is added on drive wheels.

	5 00-44 Duals -1525 lb				5 00-44 Duals—1797 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	520	0	2 25	3 12	518	0	2 49	3 44
Push	500	0	2 32	3 095	540	0	2 08	2 995
Pull	450	7 73	3 18	3 82	460	5 84	3 18	3 91
Pull	790	12 5	2 99	6 30	740	9 87	3 055	6 03
Pull	1025	17 26	2 82	7 71	1090	12 64	2 97	8 63
Pull	1280	30 15	2 38	8 13	1290	19 5	2 73	9 39
Pull	1200	32 2	2 30	7 36	1500	21 8	2 60	10 40
Pull	1430	31 6	2 20	8 40	1600	39 0	1 92	8 20
Pull	1560	49 2	1 62	6 74	1670	41 8	1 875	8 35
Pull	1420	59 2	1 33	5 04	1680	51 0	1 215	5 44

Table 8 and Curves 1 and 2 from Graph No. 5 show the advantage of added weight to the drive wheels in sandy soil in the form of increased traction.

Table 9. Tractor performance in sandy soil (oat stubble) comparing single pneumatics with singles to show the effect of traction as weight is added to drive wheels.

	9 00-36 Singles - 1797 lb				9 00-36 Singles -1525 lb			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	483	0	2 51	3 23	370	0	2 45	2 415
Push	485	0	2 11	2 73	370	0	2 36	2 33
Pull	50	1 14	3 34	0 45	150	1 03	3 39	1 357
Pull	350	3 02	3 27	3 05	370	4 12	3 25	3 20
Pull	780	6 03	3 15	6 55	730	7 63	3 18	6 19
Pull	1010	8 53	3 03	8 15	1110	10 82	2 97	8 79
Pull	1310	10 82	2 94	10 26	1290	12 28	2 94	10 11
Pull	1630	15 3	2 78	12 07	1550	21 2	2 59	10 70
Pull	1940	22 6	2 48	12 83	1750	36 2	2 07	9 67
Pull	2100	30 8	1 93	10 81	1890	50 2	1 21	6 10
Pull	2160	46 4	1 29	7 44	1800	57 8	1 03	4 94
Pull	2100	56 0	1 055	5 63	—	—	—	—

Table 9 and Curves 3 and 4 from Graph No. 5 show the effect of added weight to the drive wheels in the case of single pneumatics in sandy soil (oat stubble) as it relates to traction.

A study of Curves 1, 2, 3, and 4 from Graph No. 5 will show other relations of interest in comparing duals with singles.

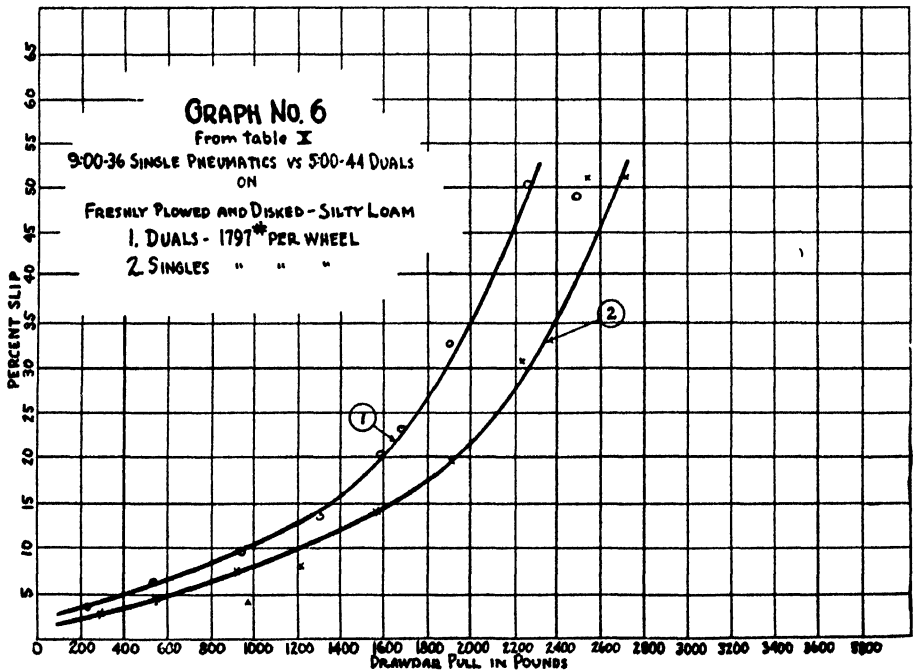
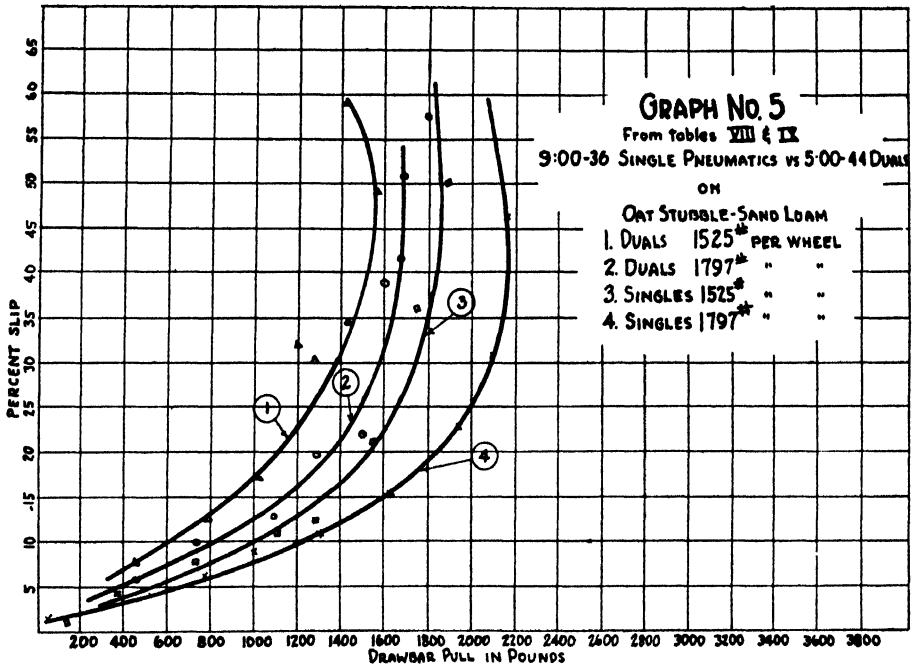


Table 10. Tractor performance in freshly plowed and disked ground (silty loam soil) comparing single pneumatics with duals with the same weight on the rear axle in each case.

	9.00-36 Singles—1797 lb.				5.00-44 Duals—1797 lb.			
	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.	D. B. Pull in pounds	Slip in per cent	Speed in M. P. H.	Drawbar H. P.
Push	443	0	2.40	2.84	475	0	2.35	2.98
Push	495	0	2.50	3.305	533	0	2.34	3.33
Push	533	0	2.49	3.54	538	0	2.69	3.86
Pull	280	2.80	3.29	2.46	220	3.67	3.39	1.99
Pull	540	4.67	3.21	4.62	540	6.38	3.22	4.64
Pull	920	7.88	3.10	7.60	940	9.63	3.10	7.78
Pull	1220	8.09	3.05	9.93	1290	13.62	2.96	10.18
Pull	1560	14.32	2.85	11.86	1590	20.50	2.73	11.58
Pull	1890	20.00	2.62	13.19	1670	23.35	2.62	11.65
Pull	2220	30.70	2.16	12.78	1890	32.70	2.235	11.28
Pull	2530	51.20	1.18	7.97	2080	39.80	1.81	10.03
Pull	2700	51.40	1.17	8.43	2250	50.4	1.28	7.67
	—	—	—	—	2480	49.1	1.26	8.33

Table 10 and Curves 1 and 2 from Graph No. 6 show traction advantage of single pneumatics as compared with duals with the same weight on each drive wheel.

Effect of Tractor Speed on Slip

Additional tests were run to determine the effect of speed changes on slip and drawbar pull on sod ground. The first, second, and third gear transmission setting, all of which are working speeds, were used in these tests. The curves drawn from the test data (not presented here) show that speed does not affect the relation between drawbar pull and slip.

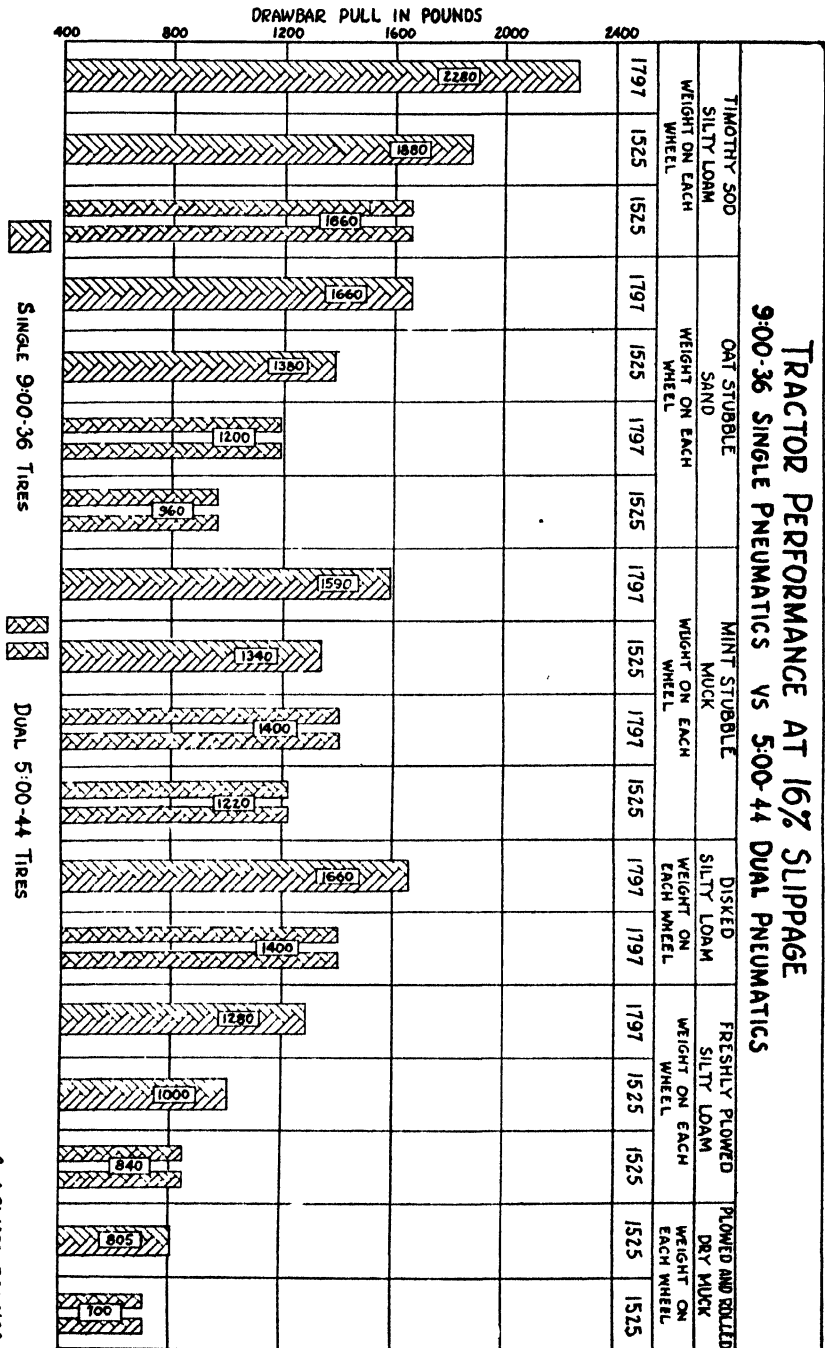
Tractor Performance at 16 Per Cent Slippage

A tractor performance chart has been prepared which summarizes all tests. Sixteen per cent slippage was used in the development of this chart because it is believed that this value represents the slippage for optimum tractor performance, considering wear on the tires. Other values could be used without materially affecting the comparison.

Conclusion

It must be clearly understood that this report deals only with a comparison of 9.00-36 single pneumatic tires with 5.00-44 dual pneumatic tires. The loaded radius of these tires when inflated as recommended, namely 12 pounds for the 9.00-36 tires and 20 pounds for the 5.00-44 tires, is approximately the same.

It will be recognized from a study of the curves and charts that in every instance the drawbar pull in pounds was greater for the single pneumatics than for the duals when the same weight was on each drive wheel. Also, added weight to the drive members improved traction in every case, regardless of the type or condition of the soil.



The traction advantage of the single pneumatics is undoubtedly explained by the greater flexibility of the low pressure singles which increases the ground contact area under load. Since the rolling resistance of the dual pneumatics averaged higher than the single pneumatics, it is reasonable to expect that the available drawbar horsepower for useful work would be lessened for the duals. Incidentally, the hitch from the pulling tractor to the dynamometer was kept horizontal for all tests except for slight variations in tire flexing and slope of the ground.

Summary

A summary of the traction tests comparing 9.00-36 single pneumatics with 5.00-44 dual pneumatics is given below. The tire inflation pressures as recommended in the tests are 12 pounds per square inch for the 9.00-36 four-ply singles and 20 pounds per square inch for the 5.00-44 four-ply duals. The loaded radius was approximately the same for both sets of tires.

1. Traction, expressed in pounds pull on the tractor drawbar, was greater for the single than for the dual pneumatics for the same percentage slippage for all soils and conditions tested.

2. The advantage in traction gained by the single pneumatic over the dual pneumatics for a slippage of 16 per cent is as follows: Sand 41.1%, disked ground 20.4%, freshly plowed ground 19%, muck (plowed and rolled) 15%, sod 13.25%, and muck (mint stubble) 11.7%.

3. Increased weight on the driving wheels of the tractor increased the traction for the same percentage of slip.

4. At 16 per cent slip, the drawbar pull increase with the single pneumatics for 544 pounds added to the traction members is as follows: Sod 400 pounds, sand (oat stubble) 280 pounds, muck (mint stubble) 250 pounds, and freshly plowed ground 280 pounds.

5. At 16 per cent slip the drawbar pull increase, with the dual pneumatics for 544 pounds added to the traction members is as follows: Sand (oat stubble) 240 pounds, muck (mint stubble) 180 pounds.

6. The maximum drawbar pull was obtained with an average slippage of 45 per cent.

7. The maximum horse-power was obtained with an average slippage of 23 per cent.

8. The coefficient of traction, that is the ratio of drawbar pull at 45% slippage, to the (zero load) weight on drive wheels is as follows:

Muck (plowed and rolled)	singles 0.38; duals 0.33
Muck (mint stubble)	singles 0.55; duals 0.50
Silty loam (sod)	singles 0.90; duals 0.82
Silty loam (freshly plowed)	singles 0.62; duals 0.54
Sand (oat stubble)	singles 0.60; duals 0.49
Silty loam (freshly plowed and disked)	singles 0.71; duals 0.60

9. The effect of changing the spacing of the duals from the standard setting of nine inches center to center, to a seven inch spacing, did not appear to affect tractive ability, for the one comparison made.

COSTS OF CREDIT EXTENSION IN THE SALE OF FARM SUPPLIES BY COOPERATIVE ASSOCIATIONS

H. E. LARZELERE AND D. D. MACPHERSON*

SECTION OF ECONOMICS

Credit extension to patrons is a major problem facing many Michigan cooperative associations. A recent study** shows that about \$11,000,000 worth of farm supplies are sold each year by 195 Michigan cooperative associations direct to their farmer patrons. It has been estimated that about \$7,000,000 of these supplies are sold on credit, representing an amount of \$2,000,000 that these associations are owed by their patrons at the end of the fiscal year.

A case study of the credit situation in six representative farmers' cooperative associations has been made by the Economics Section of the Michigan Agricultural Experiment Station. This sample method of investigation was chosen because it was thought that a detailed and intimate analysis of the credit situation of a few representative cooperatives would be more informative and suggestive than a statistical survey of the credit operations of Michigan cooperatives in general.

The six associations were chosen to represent three of the major agricultural areas in Michigan. Two of the organizations represent the dairy and general farming region of southeastern Michigan; two, the potato growing area of north central Michigan; and two, the fruit growing section of western Michigan.

All of the six cooperatives included in this survey were organized originally as marketing agencies for farmers' produce, and then later began selling farm supplies as a sideline. In recent years, however, the farm supply business has become increasingly more important. As indicated in Table 1, the value of the farm supplies sold exceeded the value of the farmers' produce marketed in four of the six cooperatives.

It is to be expected that the extent of sales on credit would be influenced by the kind of supplies sold, and the type of agriculture in the surrounding area. In the various agricultural areas, this would vary from dairy feeds which are sold in rather uniform amounts throughout the year, to fruit spray materials which would be sold only in certain months of the year. Similarly payments for those supplies would be expected to vary from semi-monthly and monthly payments that would be possible for dairy farmers, to payments within the two or three months of the year when an entire crop is sold in the fruit growing region, for example.

In the study of these associations it was found that the opposite situation actually existed. The grain and feed cooperatives in the dairy region had the highest percentage of supply sales on credit. Associa-

*Dr. H. S. Patton, Chairman of the Department of Economics has given many valuable criticisms and suggestions in the preparation of this study.

**Unpublished data of Farm Credit Administration Cooperative Survey—1937.

Table 1. Sales of farm supplies and sales of farm produce by six cooperative associations in 1937.

Association	Sales of Farm Supplies	Sales of Farm Produce	Total Sales	Per cent of Total Sales in Farm Supplies	Per cent of Supplies Sold on Credit
	(Dollars)	(Dollars)	(Dollars)	(Per cent)	(Per cent)
A	\$148,533	\$64,219	\$212,752	70 0	71 4
B	110,881	14,763	125,644	88.0	76 4
C	163,092	34,445	197,537	82 6	60 4
D	53,936	18,053	71,979	74 9	54.5
E	82,406	86,416	168,822	48 8	48 7
F	108,001	124,319	232,320	46 5	58.6

tions A and B sold 71.4% and 76.4% respectively, of their supplies on credit. On the other hand, the fruit cooperatives E and F sold 48.7% and 58.6% respectively, of their supplies on credit. The potato cooperatives C and D sold 66.4% and 54.5% respectively, of their supplies on credit. Therefore, even in the latter cases where the type of agriculture and the kind of supplies are similar, the amount of sales on credit may vary considerably. The conclusion to be reached then is that some other things are of fundamental importance in determining the various aspects of the credit problem.

Evidently the credit policies and practices which are adopted and carried out by the members, the directors, and the manager of a cooperative association have developed into the real determinant of the credit problems. The reasons for the adoption of certain practices then are especially significant in determining the various aspects of the credit problem.

An important reason for extending credit is the service or convenience which the cooperative may thus render its patrons. The farmer often does not have the ready money either when he comes for his supplies or when they are delivered to his farm. It is easier at that time to say "charge it." The association may be rendering its patrons the service of a credit institution either because of irregular agricultural income or because of the habit of buying on credit.

The extension of credit also represents one of the forms of competition between various agencies selling supplies. The cooperative is often obliged to consider the credit and collection practices of the private supply dealers in the same trade area. Of course, it may be that the private dealers are compelled to extend credit in order to meet the competition of the cooperative.

The purpose of any credit practice is to expand the volume of the business which may enlarge the margin of net income. This means attracting new patrons by extending more service or more liberal credit than that offered by any other agency.

On the other side of the picture, there have been several disadvantages to the extension of credit. These disadvantages or costs have been recognized to varying degrees but in most cooperative associations very little has been done to change their credit practices accordingly. It is with this phase of the problem that this study is more specifically concerned. The results represented in the six associations

in this study illustrate only the problem of credit costs and do not apply directly to all cooperatives.

The first disadvantage consists of the actual computable costs of the practice of extending credit. These costs are made up of three major items: bad debt losses, credit administration expense, and interest cost on outstanding receivables. The bad debt losses represent the amount of the accounts receivable which the associations are not able to collect. The administrative expenses represent such costs as extra accounting forms, statements and postage that are necessary with a program of credit extension, and part of the bookkeepers' and managers' salary for time spent in dealing with the credit operations. These expenses are, of course, part of the general expenses recognized by the associations in drawing up their profit and loss statements, but are not designated by the associations as credit costs.

The interest cost while not listed as a definite cost by the cooperative should be computed, because when credit is extended, the association is in effect lending money to its credit patrons and should expect a return on its investment in accounts receivable. It is often necessary for the association to borrow from banks and other institutions if a considerable amount of the operating capital is tied up in accounts receivable. Therefore, the cooperative is actually borrowing money and paying interest so that it can sell on credit. The average rate of interest paid for the borrowings of the associations in this study was 6% per annum or .5% per month. This rate was applied to the amount of outstanding receivables on record at the end of each month to determine the amount of interest cost.

In the six associations studied, the three computable credit costs amounted on the average to \$2.11 for \$100 worth of all supplies sold through these organizations. On the basis of the sales on credit which were the direct cause of these costs, there was a credit expense of \$3.29 per \$100 of credit sales. A breakdown of this cost as indicated in Fig. 1 shows that \$0.91 was for bad debt losses, \$1.28 was for ad-

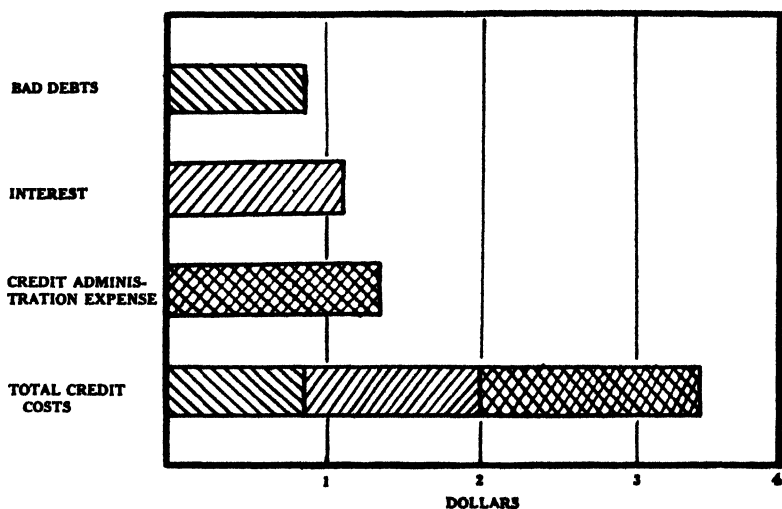


Fig. 1. Credit costs per \$100 of credit sales.

Table 2. Credit costs per \$100 of total sales and credit sales.

Association	Bad Debt Losses		Credit Administration Expense		Interest Cost		Total	
	Total Sales	Credit Sales	Total Sales	Credit Sales	Total Sales	Credit Sales	Total Sales	Credit Sales
A	\$1.07	\$1.49	\$0.74	\$1.04	\$0.57	\$0.80	\$2.38	\$3.33
B	0.51	0.67	1.05	1.37	1.11	1.46	2.67	3.50
C	0.55	0.83	0.68	1.02	0.51	0.76	1.74	2.61
D	0.78	1.43	0.87	1.60	0.91	1.67	2.56	4.70
E	0.34	0.59	0.68	1.17	0.94	1.60	1.98	3.36
F	0.12	0.26	1.03	2.10	0.50	1.02	1.65	3.38
Average	0.58	0.91	0.82	1.28	0.71	1.10	2.11	3.29

ministrative expense attributable to credit operations and \$1.10 for interest cost.

While these average credit costs for six associations give an indication of the credit situation in many Michigan cooperatives, it must be pointed out that the credit costs of individual associations may vary considerably from these averages. As indicated in Table 2, the credit costs ranged from \$1.65 for association F, to \$2.67 for association B for \$100 of total sales, and from \$2.61 for association C, to \$4.70 for association D for \$100 worth of supplies sold on credit. It is significant to note that these two sets of figures do not apply to the same two associations. The difference can be partly accounted for by variations in the proportion of total supply sales on credit.

Similar variations from the average occur in the several items making up the total credit cost. The average bad debt loss for the six associations was \$0.91 for \$100 worth of credit sales, while the losses ranged from \$0.26 to \$1.49 per \$100 of credit sales for individual associations.

The average credit administrative expense was \$1.29 per \$100 of credit sales. This expense ranged from \$1.02 to \$2.10 in individual associations.

The average interest cost was \$1.10 per \$100 of credit sales, and interest cost in each association ranged from \$0.76 to \$1.67 per \$100 of credit sales. Directly related to the amount of interest cost of selling on credit is the length of time for which the credit is extended. The average age of all accounts in the six associations was 57 days. The average age of accounts for individual associations varied from 39 days for association C to 84 days for association D. The fact that the cooperatives with the highest and lowest relative interest costs are the same type of association, indicates the differences, at least, in regard to credit practices that may occur because of variations in the business operations and policy. Also the ease and possibility of collection of accounts varies inversely with the length of time that the accounts are allowed to run.

The full significance of these costs can be interpreted by their effect on the net income of the association. To illustrate in the case of these six associations, for each \$100 of goods sold, \$96.64 represented the cost of goods sold and general expenses, of which \$1.40 could be allocated to bad debt losses, and credit administration expense. Add-

ing the computed interest cost of \$0.71 to the general expenses would make \$97.35 and would leave an average net margin of \$2.65 for these organizations.

If we assume a separation of the supplies sold on credit and those sold for cash, the total cost of goods sold and general expenses exclusive of credit costs would be \$95.24 per \$100 of sales, leaving a net margin of \$4.76. For the sales on credit the costs will be \$95.24 plus the extra expense for selling on credit of \$3.29, leaving a net income margin of \$1.47 per \$100 of sales.

Other costs or disadvantages of extending credit are less tangible than those listed above, but nevertheless, are worthy of important consideration. The figures indicate that the patrons who pay cash are sharing the costs of credit for which they are not at all responsible. If cash customers are driven away because they share the costs incurred by the credit customers, the association will be losing its best patrons. Such a loss may nullify the additional business of new patrons who may be attracted as a result of extending credit.

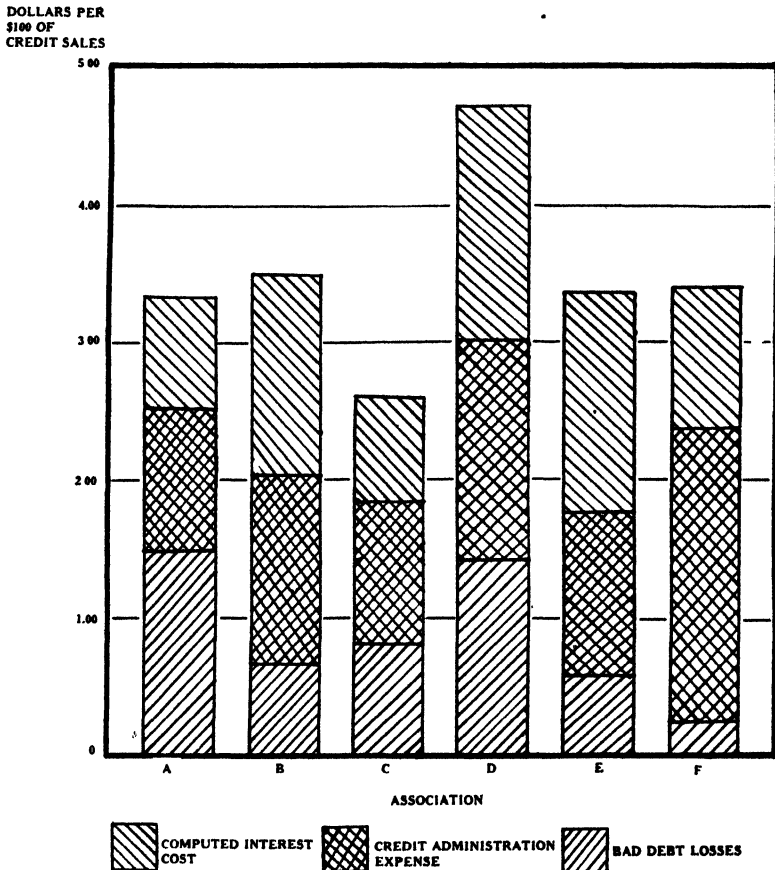


Fig. 2. Comparative credit costs of six Michigan cooperative associations per \$100 of credit sales.

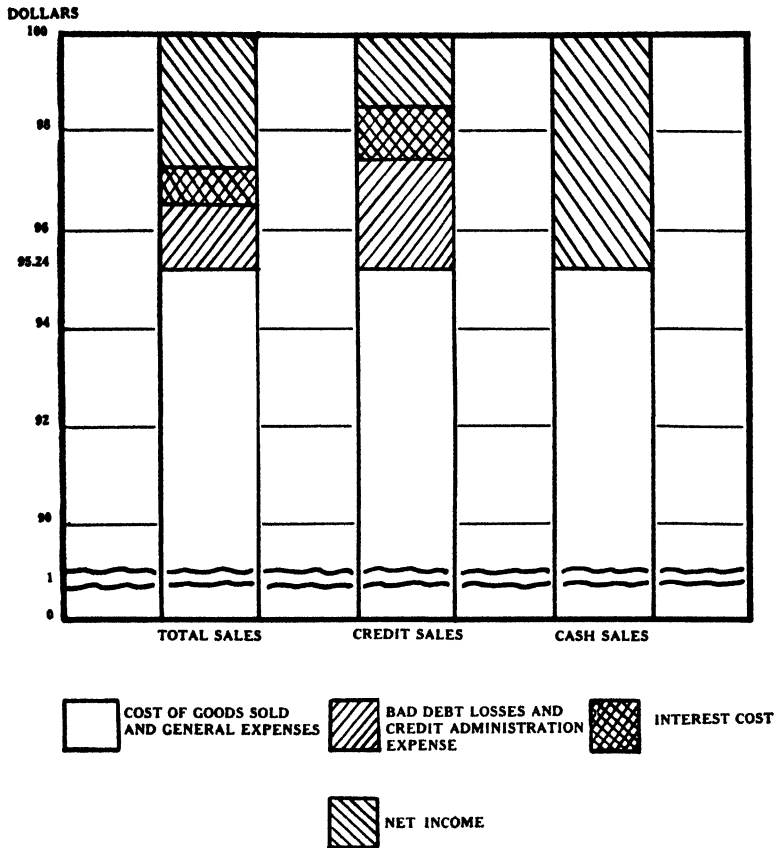


Fig. 3. Effect of credit costs on net income.

While the use of credit may serve to stimulate the volume of sales and attract more customers, credit extension and collections always involve a certain amount of ill-will. It is difficult to draw the line between good credit risks and bad credit risks without having some dissatisfied patrons. Then it is hard to press the collections of accounts, especially when the supplies purchased may have been used up several months earlier.

High costs of credit tend to limit the amounts of patronage dividends that can be paid to customers. The difference in net margin (Fig. 3) between \$4.76 and \$2.65 per \$100 of sales will account for a sizable difference in the amount of patronage dividends that can be paid. The possibility of paying patronage dividends is one of the principal competitive advantages of a cooperative organization. Business policies and operations therefore should be based on the principle of obtaining as large a margin of savings as possible to rebate to patrons.

A further disadvantage is the additional working capital which the extension of credit involves. When a supply organization, whether it is a cooperative or a private dealer, sells to its patrons on credit, it is

really financing these patrons. To many farmers this is a source of production credit. By financing patrons, however, the cooperative is preventing itself from operating at the greatest level of efficiency. Credit extension means tying up working capital and cash funds which should be available to permit paying cash to get discounts on purchases from supply manufacturers. Furthermore, capital tied up in accounts receivable does not permit shifts toward greater efficiency, such as expansion of inventories to add new lines, or the addition of new fixed assets that may be needed.

The examination of these advantages and disadvantages of extending credit in six cooperative associations will be a useful method of analyzing the credit situation in any particular cooperative. In the case of one association the advantages of extending credit may outweigh the disadvantages and a liberal extension of credit could be recommended. However, if the advantages seemed to balance approximately the disadvantages, a restricted credit policy would be desirable. On the other hand, if the disadvantages of extending credit outweighed the advantages, a policy of cash sales could well be adopted.

Whatever the results of this analysis of an association's credit situation, the important conclusion to be reached is that the extension of credit is to become a policy and not merely a series of practices or decisions by the manager. Furthermore, the policy should represent the coordinated effort of members, directors, and the manager.

Difficulties may be encountered in shifting from an uncertain and liberal credit situation to a restricted credit or cash policy, and many cooperative leaders may feel that credit is a "necessary evil" that cannot be eliminated. Whether this is true, some associations are succeeding on a strictly cash basis. They have gained much of the cash business of their localities and have left the credit costs, risks, and worries to their competitors.

In establishing a restricted credit policy, several practices should be adopted. First, the credit period should be short, ranging from 10 to 60 days depending upon the type of commodity sold and the regularity of farm income in the area. Second, the amount of credit that will be extended to each patron should be definitely limited. This limit may vary according to the amount of capital that the cooperative can safely have tied up in receivables; however, the most commonly used limit is \$100 for each individual customer. Third, credit costs may be reduced by offering an incentive to customers who pay cash and by penalizing those customers who abuse the privilege of buying on credit. This may be accomplished by offering cash discounts, by charging interest on over-due accounts, and by encouraging patrons to finance their purchase through credit unions and Production Credit Associations. The practice of giving cash discounts will reduce the net margin available for patronage dividends, but since the cash customer receives a discount, only the credit customer would be penalized. Charging interest on over-due accounts and encouraging loans from regular credit institutions forces the customer to pay his own credit costs. Such measures not only reward the good customers and penalize the poor customer but also help the financial condition of the organization as a whole.

Modern large-scale commercial organizations have long realized the need for the separation of the merchandising and financial functions.

If the cooperative can perform both functions, no more need be said; but if merchandising and financing do not work efficiently in the same organization, it should be remembered that the cooperative was really organized to bring about more effective merchandising.

Summary

There are four conclusions:

1. The type of agriculture in which a cooperative's patrons are engaged is only a partial explanation for the credit practices followed by that organization.
2. The true cost of extending credit is much higher than is indicated by the financial statements of cooperatives and may itself tend to reduce the net income.
3. While the liberal use of credit may expand the volume of sales, its effect is found to be accompanied by a reduction in the net earnings of the associations concerned.
4. The establishment of a definite credit policy will enable the association to adjust its credit operations to the highest level of efficiency.

FEEDING AND CONFINEMENT REARING EXPERIMENT WITH TURKEYS DURING 1938 (Fourth Report)

F. N. BARRETT, C. G. CARD AND ASHLEY BERRIDGE
SECTION OF POULTRY HUSBANDRY AND LAKEL CITY EXPERIMENT STATION

Previous to 1937, the feeding and management trials with turkeys were concerned mainly with the development of a ration that would adequately provide for perfect development of turkeys reared under confinement where an understanding of basic requirements is imperative. This apparently has been accomplished with mash 7 which is an excellent starting and developing ration when fed in conjunction with grain and green feed. A modification of mash 7 has been made in developing ration 10 which permits a complete substitution of barley for corn with results that are equally favorable. An account of the work with the barley ration, as well as ration 7, was reported in the Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 21, No. 2, November, 1938. Since 1936, emphasis has been placed on reducing feeding and rearing costs, without limiting the finest development of the birds, to make possible the production of turkeys of the best quality at the lowest possible expense.

1938 Objectives

The 1938 trials are primarily an effort to explore some of the little understood factors of turkey production. More information is needed with reference to the value of succulent green feed and its possible

use in greater quantities with growing turkeys, as well as the possible merits of different fresh green plant materials such as alfalfa, blue grass or young cereal growth. An approach to this problem was started this year with six pens of 20 birds each, which is explained in detail in the feeding plan later in this report.

Another series of trials was started this year with reference to the grain part of the diet. It is generally assumed that corn is the only cereal grain to be used in rearing and finishing market turkeys and very little work has been reported on the relative merits of wheat, oats, and barley. Three pens of turkeys were employed in the free-choice hopper feeding trials, using the four grains previously mentioned in combination with our standard mash number 7 and also with a concentrate mash number 13. The birds were given a free opportunity to show a possible preference for certain grains at the various stages of development. Cost and rearing studies were also started in a limited way with a small type Bronze turkey in which there is considerable interest among growers of this state. There is some difference of opinion as to the economy of raising this type of turkey which needs to be answered. Some of the trials initiated this year are definitely of an exploratory nature and it is expected that some of these studies will continue, with possible modifications, for an indefinite period.

Incubation and Starting Methods

The poults used in these trials were hatched at the poultry laboratory at East Lansing from eggs produced by the breeding flock of Bronze turkeys at the Lake City Experiment Station. The poults used in pens 1 to 4 inclusive, were hatched April 25. Poults hatched on May 9 were used in pens 5 to 9, inclusive. Small type Bronze poults were used in pen 10 and because of the small numbers of eggs available, it was necessary to combine birds hatched on both April 25 and May 9.

As in previous years, the young poults were removed from the incubator when dry and placed in baby chick shipping boxes for the first 24 hours. They were then placed under small brooders in the laboratory building in lots of about 40 poults each. Mash in hoppers, together with water in vacuum fountains, was the only food given for the first week, with the exception of a small amount of hard-cooked egg which was added to the diet for the first few days. Burlap was used for a floor covering for the first three or four days, until the poults were accustomed to eating mash, after which time fine shavings were used until the birds were removed to Lake City.

Experimental Pens at East Lansing

At the end of the first week the poults were sorted into experimental lots of 28 each. Each lot was provided with an indoor pen, 4½ feet wide and 10 feet long, with an electric hover. Perches were added when the hovers were no longer required.

As the poults for the second trial were hatched two weeks later than those of the first trial, it was necessary to remove the first lot to quarters in a laying house to give the preferred location in the laboratory to the younger birds. The birds remained in these quarters until removed to Lake City at the end of the eighth week.

The poults of the second trial remained in the quarters first mentioned until the end of the seventh week. With each trial it was necessary to keep the poults under the conditions described until their age and the weather conditions made it possible to transfer them to the large, open turkey house at Lake City.

The Lake City Turkey House

At the Lake City Station, each group of turkeys was confined to a pen 10 feet wide and 24 feet deep in the open-front turkey house. This building, which is 100 feet long, is constructed of rough lumber and poles. The house is divided into 10 pens with wire and wood partitions. At the end and back walls are hinged panels that may be opened for summer ventilation. At the rear of each pen are perches and a dropping board. The floors are of concrete, and straw was used for litter.

Feeding Plan

With the trials in which the value of green feed was the consideration, six pens of Standard Bronze turkeys were used. Pens 1 to 3, inclusive, included poults hatched on April 25 and pens 5 to 7, inclusive, contained birds hatched two weeks later. All of these birds were hopper-fed mash 7 for the entire period, and corn was also hopper-fed from the end of the eighth week until the completion of the trials. Four pens received green feed, and this was furnished in liberal amounts from the end of the eighth week until the trials were terminated. With the exception of the short lawn grass, all green feed was run through a cutting box. An effort was made to keep this green plant material available in slatted racks throughout each day. Some difficulty was encountered in providing a suitable supply of young oat growth and at times this material was more mature than would have been desired. In accordance with the feeding plan, which is outlined in Table 1-A, pens 1 and 5 received no succulent green feed at any time during the

Table 1. Rations.

Mash Number	7	13
Protein Content of Mash	27.5%	31.0%
Ground yellow corn	10	6
Ground oats	15	15
Wheat bran	10	10
Wheat flour middlings	10	—
Meat scrap	14	12
Fish meal	—	8 5
Dried skim milk	10	10
Soybean oil meal	22	25
Alfalfa meal	5	10
Calcium carbonate	1	2
Salt	1	1
*Cod liver oil	2	.5xx
Total	100	100

*Cod liver oil was discontinued after the sixteenth week.

Table 1-A. Feeding plan.

Pen	**No. of Birds	Hatching Date	Mash	Grain	Green Feed
1	20	Apr. 25	7	Corn	None
2	20	Apr. 25	7	Corn	Alfalfa
3	20	Apr. 25	7	Corn	Lawn Grass
*4	20	Apr. 25	7 and 13	Corn, wheat, oats and barley	Alfalfa
5	20	May 9	7	Corn	None
6	20	May 9	7	Corn	Alfalfa
7	20	May 9	7	Corn	Green Oats
*8	20	May 9	7 and 13	Corn, wheat, oats and barley	Alfalfa
9	20	May 9	7	Corn, wheat, oats and barley	Alfalfa
10	7	May 25	7	Corn	Alfalfa
	5	May 9			

Mash was available at all times from the first day to the end of the trials.

Grain, gravel, and green feed when used, were added to all diets at the end of the eighth week.

Wheat, oats, and barley, however, were not added to the diet of pen 4 until the end of the tenth week.

*Pen 4 received mash 7 until the end of the tenth week, and pen 8 received mash 7 until the end of the eighth week after which time both pens received mash 13 until the completion of the trials

**A starting number of 28 baby poultts was allotted to pens 1 to 9, inclusive, and, at the end of the eighth week, these pens were equalized to 20 poultts each for a true comparison of the significant factors which were introduced at that time.

trials. Chopped alfalfa was the green feed furnished to pens 2 and 6. Pen 3 received fresh cut lawn grass, while pen 7 was provided with the green oat growth.

With the free-choice grain feeding trials pens 4, 8, and 9 were used. Pen 9 received mash 7 for the entire period. The birds in pen 4 received mash 7 until the end of the tenth week and in pen 8 until the end of the eighth week, at which time they were changed to mash 13 until the completion of the study. Mash 13 is a concentrate mash, with a protein content of 31 per cent, and mashes of this type are expected to bring about the consumption of relatively large amounts of grain. Corn, wheat, oats and barley were hopper-fed, in an equal and free choice manner to all three pens. Pens 8 and 9 were started on these four grains at the end of the eighth week while pen 4 received

Table 2. Proportion of mash and grain consumed.*

(Total mash and grain consumed equals 100)

	0-4 weeks		5-8 weeks		9-12 weeks		13-16 weeks		17-20 weeks		21-24 weeks		25-26 weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1	100	0 0	100	0 0	98 8	1 2	92 6	7 4	71 5	28 5	45 7	54 3	25 4	74 6
2	100	0 0	100	0 0	99 6	0 4	90 4	9 6	60 1	39 9	39 0	61 0	23 8	76 2
3	100	0 0	100	0 0	99 7	0 3	92 1	7 9	64 3	35 7	35 9	64 1	22 1	77 9
4	100	0 0	100	0 0	86 9	13 1	55 6	45 4	38 6	61 4	38 0	62 0	3 4	96 6
5	100	0 0	100	0 0	88 7	11 3	84 5	15 5	56 6	43 4	38 3	61 7	20 1	79 9
6	100	0 0	100	0 0	80 6	19 4	81 0	18 4	62 7	37 3	39 6	60 4	28 0	72 0
7	100	0 0	100	0 0	88 4	11 6	82 6	17 4	55 0	44 4	41 7	58 3	26 9	73 1
8	100	0 0	100	0 0	73 6	26 4	58 0	42 0	23 5	76 5	6 5	93 5	1 8	98 2
9	100	0 0	100	0 0	69 8	30 2	63 9	36 1	39 1	60 9	16 1	83 9	7 3	92 7
10	100	0 0	100	0 0										

Not Comparable

*Mash in hoppers from the start. Grain in hoppers after the eighth week until the end of the period.

corn only from the eighth to the tenth week when the wheat, oats and barley were added. These grains were available at all times for the birds in two, regular, turkey feeding hoppers, each of which was provided with a central partition making four equal compartments. Each compartment was 8 inches wide and 2 feet long with an opportunity to eat from either side. Each week, at time of weighing, the grains were arranged in a new combination to eliminate the possibility of any advantage due to location.

It was possible to start the work with the small-type Bronze turkeys only in a very limited way, owing to the small number of breeders and rather poor hatchability. Only 12 poults from the hatches of April 25 and May 9 were available to form pen 10. The results of the year are presented primarily as a matter of record and the work will be continued in 1939.

Results

Free Choice Feeding Influenced Amount of Grain Consumed—It is of interest to note, in Table 2, that pens 4, 8, and 9 which were provided with a free choice of corn, wheat, oats and barley consumed a significantly greater proportion of grain to mash than those pens which received corn only as the grain part of the diet. It was expected that the high-protein content of the mash which was fed pens 4 and 8 would result in a large grain intake, but it was surprising to note that pen 9, which was fed the standard check mash 7, followed the same general pattern with reference to proportion of mash and grain consumed. Pen 9 even exceeded pen 4 as a consumer of grain during this trial but did not equal pen 8. Pen 9 is comparable with pens 2 and 6, the only difference being that pens 2 and 6 received corn only from the eighth week on to the end while pen 9 received a choice of corn, wheat, oats and barley. A comparison of these three pens in the tables which follow will be of interest. There was no significant difference in the proportion of grain to mash which was consumed by any of the six pens in the trials with green feed.

Turkeys Showed Preference for Certain Grains—Of the grains fed, oats ranked first with all three pens. Birds in all pens ate oats eagerly from the outset and the amounts increased steadily as the season advanced. During the finishing weeks, oats remained the preferred grain but wheat rather than corn gained in position at the finish. Corn was eaten rather indifferently by pens 4 and 8 throughout the trials. Pen 8 consumed a total of only 29.5 pounds of corn in the last nine weeks while consuming 366.5 pounds of oats and 319.0 pounds of wheat. Pen 9 ate somewhat more corn than wheat and oats for the first few weeks, but corn consumption declined and that of oats and wheat advanced with the season. Although the quality of the barley was good the birds did not care much for it. For the entire period, pen 4 consumed a total of 22.0 pounds, pen 8 only 3.0 pounds while pen 9 ate 70.5 pounds of the barley. In 1937, two pens of turkeys, to which barley was the only grain given, ate barley eagerly and consumed a greater poundage of this grain than corresponding pens did of corn. The percentage of the total grain consumption for each of the four grains used this year is as follows:

	Pen 4	Pen 8	Pen 9
Corn	16%	13%	30%
Wheat	40%	33%	25%
Oats	44%	54%	37%
Barley	Neg.	Neg.	8%
Total	100%	100%	100%

Feed Consumed per Pound of Gain—One of the measures of the efficiency of a diet is the proportion of mash and grain, as well as the total quantity of these ingredients that is required to produce a unit of gain in weight in the birds. The average amount of feed consumed per pound of gain to 24 weeks of age is given in Table 3. Relatively high grain consumption usually results in a corresponding decrease in the amount of mash consumed.

Table 3. Pounds of feed consumed per pound of gain.

Feed	Pen.									
	1	2	3	4	5	6	7	8	9	10
Mash.....	3 49	3 41	3 43	2 35	3 22	2.83	2 98	2 06	2 21	3 17
Corn.....	1 02	1 21	1 19	.33	1 50	1.39	1.29	34	64	1 50
Wheat.....				80				83	54	
Oats.....				89				1 37	80	
Barley.....				06				01	20	
Mash and Grain Total	4.51	4.62	4.62	4.43	4 72	4.22	4.27	4 61	4.39	4 67

Average Cost of Producing a Pound of Gain—The cost of producing a unit of gain should be considered in determining the merit of any ration. This information is given for each pen in Table 4. Consideration should also be given to the normal development of the birds, the growth rate, physiological effect of the diet, the character of the finished product, and any other advantage or disadvantage of the particular ration before conclusions are drawn.

Table 4. Feed cost per pound gain.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash.....	\$.070	\$.068	\$.069	\$.051	\$.064	\$.057	\$.060	\$.045	\$.044	\$.063
Corn.....	.014	.016	.016	.004	.020	.018	.017	.005	.009	.020
Wheat.....				.009				.009	.006	
Oats.....				.006				.000	.005	
Barley.....				Neg.				Neg.	.003	
Mash and Grain Total ...	\$.084	\$.084	\$.085	\$.070	\$.084	\$.075	\$.077	\$.068	\$.067	\$.083

1938 Feed Prices—The average prices paid for the different mashes and grains are shown in Table 5. Feed prices for this season were approximately 23 per cent below those of 1937, which materially influenced the cost of producing a pound of gain.

Table 5. Feed price per 100 pounds.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash 7.....	\$2 00	\$2 00	\$2 00	\$2 00	\$2 00	\$2.00	\$2 00	\$2 00	\$2.00	\$2.00
Mash 13.....				2.25				2 25		
Corn.....	1.33	1 33	1 33	1 33	1 33	1 33	1 33	1.33	1 33	1.33
Wheat.....				1 10				1 10	1 10	
Oats.....				63				63	63	
Barley.....				1 38				1 38	1 38	

Growth Rates—The rate of growth of the different groups may be noted from the data presented in Table 6. This table gives the average weights of both male and female turkeys at the end of each four-week period to 24 weeks of age and, in addition, the results to 26 weeks are included.

Table 6. Growth of turkeys.
(Average weight in pounds)

Pen	4 weeks		8 weeks		12 weeks		16 weeks		20 weeks		24 weeks		26 weeks	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1.....	.93	.84	3.24	2.62	7.42	5.74	11.23	8.50	15.45	11.14	18.75	12.86	20.35	13.56
2.....	.82	.91	3.17	3.16	6.50	6.10	10.73	9.38	15.42	12.09	19.32	14.07	21.02	15.00
3.....	.86	.88	3.03	2.89	6.92	5.94	11.05	8.89	15.91	11.50	19.60	13.51	21.11	14.50
4.....	.94	.84	3.21	2.74	7.37	6.24	11.44	9.07	15.78	11.81	19.79	14.08	21.28	15.01
5.....	.91	.80	3.44	3.01	7.08	6.03	10.71	8.86	14.68	11.33	18.79	13.43	20.47	14.34
6.....	.84	.84	3.07	2.92	6.43	5.92	10.60	8.95	15.21	11.73	19.17	13.73	20.87	14.90
7.....	.98	.83	3.68	2.79	7.40	5.53	11.41	8.30	16.30	11.17	20.19	13.03	22.03	14.03
8.....	.95	.77	3.48	2.55	7.45	5.38	11.56	8.28	16.20	11.03	19.65	12.81	21.42	13.80
9.....	.92	.82	3.45	2.78	7.29	5.66	11.31	8.37	16.17	11.12	19.73	13.03	21.42	13.76
10.....	.71	.66	2.48	2.12	5.56	4.18	8.51	7.77	12.07	8.20	14.97	9.22	16.37	9.86

Mortality—The mortality for 1937 was not excessive. During the first eight weeks 5 poults died and 4 were killed because of being crippled or general inferiority, out of a total of 252 included in the pens at one week of age. When the pens were re-established at the end of the eighth week, 180 birds were included and of this number 175 came through to the completion of the trials in good marketable condition. Two of the five birds not completing the trials were removed near the finish because of crippling, two died, and one was accidentally killed.

Final Weights—The final weights of both male and female turkeys are given in Table 7 for each pen. There was very little difference in quality at the finish with any of the pens and all were good. There

Table 7. Final weights of turkeys in pounds at 24 weeks of age.

	Pen									
	1	2	3	4	5	6	7	8	9	10
*Birds Started.....	20	20	20	20	20	20	20	20	20	12
Surviving Birds.....	19	19	19	19	19	20	20	20	20	12
Total Weights.....	326 9	309 4	299 4	336 1	308 8	318 1	346 4	283 6	341 1	150 9
Number of Males.....	14	8	7	12	10	8	12	4	12	7
Heaviest Male.....	20 4	20 7	20 5	21 7	20 7	21 9	22 6	20 7	21 4	16 2
Lightest Male.....	16 7	16 1	17 7	18 1	16 2	16 5	18 2	17 9	18 6	12 5
Average Weight.....	18 75	19 32	19 60	19 79	18 79	19 17	20 19	19 65	19 73	14 97
Number of Females.....	5	11	12	7	9	12	8	16	8	5
Heaviest Female.....	14 5	16 0	14 7	14 4	14 5	14 7	14 4	14 9	14 6	10 1
Lightest Female.....	11 4	12 5	12 0	13 5	12 2	11 8	12 0	11 0	11 8	8 3
Average Weight.....	12 86	14 07	13 51	14 08	13 43	13 73	13 03	12 81	13 03	9 22

*At end of eighth week.

were very few cases of crooked keels and these were not significant on any one diet.

Observations—In the trials in which the use of green feed or the value of any particular kind of green feed were the considerations, there was no observable differences that could be termed conclusive. All birds were active and alert, made satisfactory growth, feathered well and had lustrous plumage, developed no special abnormality, and looked equally as good in the pens, regardless of whether they were provided with green feed or what kind of green feed was used. There appeared to be a slight advantage with the dressed carcasses in favor of the pens receiving lawn grass and green oats over those receiving alfalfa or no green feed, although all were rated as good. The costs per pound of gain were almost identical with pens 1, 2, and 3 of the first trial, while with pens 5, 6, and 7 of the second trial the pen receiving no green feed cost nearly a cent a pound more than those receiving alfalfa or green oats. It is realized that there is need for more work on this subject with some modifications of this year's procedure.

Some of the observations with reference to the free-choice feeding of grain with turkeys have already been mentioned. This method of feeding was used to observe possible preferences for certain grains or perhaps seasonal trends that might have a bearing on feeding practice. This work with grains will be continued as several interesting possibilities are suggested.

The new concentrate mash number 13, which was used for the first time this year, gave very satisfactory results for a mash of this type.

Summary

The feeding of four kinds of grain to turkeys on a free-choice basis increased the total amount of grain consumed and the proportion of grain to mash.

When corn, wheat, oats and barley were presented in an equal man-

ner, the birds consumed more pounds of oats than any other single grain and were consistent in this respect in all three pens.

Oats were eaten eagerly from the start of the grain feeding to the finish, and was the preferred grain during the final weeks in total pounds consumed.

Wheat rather than corn gained in position at the finish. Corn was eaten rather indifferently by pens 4 and 8 throughout the trials.

Although the quality of the barley was good the birds ate sparingly of it.

While the work with grains this year is not conclusive, the results strongly suggest a possible advantage in including hoppers of whole oats along with corn, or even with wheat, throughout the grain feeding period.

The work conducted with green feed this year is not conclusive, and more work is needed before definite conclusion can be drawn.

The concentrate mash 13, which was used for the first time this year, gave very satisfactory results in the manner used. Work with this mash will be continued in 1939.

The limited trial with small type Bronze turkeys is presented merely as a matter of record. No conclusions should be drawn until more studies have been made.

The cobblestone turkey yard, which was first used at the Lake City Station in 1937, continues to give very satisfactory results. The results of the first year were so satisfactory that a second yard was constructed in 1938. Each of these yards which are 75 feet square accommodates 100 turkeys to maturity. Thus far, no disease problem has developed.

THE USE OF HIGH-PROTEIN LAYING MASHES

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The use of laying mash has been well established in poultry husbandry. This has been due to the necessity of incorporating high-protein carriers from animal and vegetable sources in the laying ration. The usual procedure has been the addition of sufficient amounts of meat scrap, fish meal, dried milk, soybean oil meal, cottonseed meal, and similar material to produce a mash that will analyze 16 to 20 per cent crude protein.

It has been recently demonstrated that continuous hopper feeding of grain, as well as mash, is a satisfactory management procedure. This has been referred to by some workers as the "cafeteria" feeding system. With the development of supplements (high-protein carriers) by which the poultry keeper or farmer can produce a laying mash complete in many respects by the addition of certain amounts of the cereal grains and their by-products, the possibility of permitting the flock access to the high-protein carriers direct without dilution with the cereals or their by-products presents itself.

A few bulletins on feeding for egg production carry suggested high-protein supplements. These vary from 26 per cent to 32 per cent. The majority of commercial supplements are found within this range.

During the last three years a supplement (high-protein mash) has been fed to a pen of birds in the station flock for the purpose of studying the results in comparison with the use of the regular type of laying mash. The same sources of animal and vegetable protein carriers were used. The grain has been fed continuously in hoppers.

1936-37 Trial—White Leghorns

In 1936 two pens of White Leghorns of 100 birds each were used. Corn and wheat, equal parts mixed in the same feeder, oats in another feeder, and the mashes were kept before the birds. Oyster shell and ground poultry bone were also before the birds at all times. The mashes were as follows:

Laying Mash		High-Protein Mash or Supplement	
Ground yellow corn.....	27.3	Wheat bran	19
Ground oats	13.0	Alfalfa meal	20
Wheat bran	15.0	Soybean oil meal	15
Flour middlings	15.0	White fish meal	15
Alfalfa meal	8.0	Meat scrap	15
Soybean oil meal	5.0	Dried skimmilk	12
White fish meal	5.0	Vit. D supplement (400D).....	2
Meat scrap	5.0	Salt	2
Dried skimmilk	5.0		
Vit. D supplement (400D).....	.6		
Salt	1.0		

The laying mash would be an 18-per cent protein carrier and the supplement a 30-per cent protein carrier under the usual commercial guarantee.

Results

Tables 1 and 2 give the results of the trial from Nov. 1, 1936 to Aug. 31, 1937. Birds in pen 9 received the high-protein mash and those in pen 11 the normal mash. During December, January, February, and

Table 1. Feed consumption per bird.

	Corn and Wheat		Oats		Mash		Shell		Bone		Corn-meal		Total	
	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11
Nov.....	4.277	4.033	.261	.245	.692	.978	.120	.105	.040	.043	.....	.....	5.390	5.404
Dec.....	4.354	5.-16	.197	.251	.727	1.399	.039	.149	.152	.128	.089	.....	5.558	6.943
Jan ..	5.629	5.018	.217	.312	1.198	1.655	.246	.224	.124	.073	.291	.....	7.705	7.282
Feb.....	5.332	4.507	.453	.429	1.200	2.153	.236	.210	.079	.060	.286	.....	7.586	7.350
Mar.....	6.123	5.319	.279	.262	1.292	2.509	.338	.316	.117	.126	.229	.....	8.378	8.532
Apr.....	5.666	4.664	.568	.548	1.010	2.436	.196	.277	.151	.053	.....	.....	7.591	7.978
May.....	5.522	4.669	.672	.886	1.272	2.168	.299	.275	.121	.050	.....	.....	7.886	8.048
June.....	5.211	3.956	.443	.982	1.219	2.901	.180	.101	.140	.045	.....	.....	7.193	7.985
July.....	4.691	3.621	.840	.817	1.170	2.632	.264	.430	.104	.060	.....	.....	7.069	7.560
Aug.....	4.545	3.635	1.018	1.028	1.231	2.750	.195	.266	.108	.086	.....	.....	7.097	7.765
Total.....	51.350	44.438	4.948	5.760	11.018	21.581	2.113	2.353	1.136	.724	.895	.....	71.453	74.856

Table 2. Egg production and mortality.

	Number Eggs		Per cent Production		Eggs per Bird		Deaths	
	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11	Pen 9	Pen 11
Nov.....	718	721	25 85	24 71	7.76	7.41	2	3
Dec.....	272	720	10 44	25.64	3 24	7.95	7	6
Jan.....	1,195	1,319	48.70	49 44	15 10	15.33	10	7
Feb.....	1,316	1,150	64.99	51 43	18.20	14 40	2	5
Mar.....	1,401	1,355	63.65	59 82	19 73	18.54	4	8
Apr.....	1,106	1,178	54 11	59 40	16 23	17 82	3	4
May.....	1,060	1,117	54 43	59 07	16.87	18 31	5	6
June.....	910	1,114	53.28	64 43	15 98	19 33	7	3
July.....	803	1,026	52 90	61 14	16 40	18 95	4	2
Aug.....	661	862	45 21	57 20	14 02	17 73	4	3
Total.....	9,551	10,562	46 01	48.71	143 53	155.77	48	47

March a small amount of corn meal was fed daily to which was added the supplement in order to increase the vitamin D intake since the birds were consuming less of the supplement than was anticipated. That procedure was used in an attempt to keep the intake of Vitamin D supplement approximately the same in both pens.

The total feed consumption was slightly less where the supplement was fed. Almost twice as much of an 18-per cent protein mash was consumed as of the 30-per cent protein mixture.

There was a difference of 2.7-per cent in egg production in favor of 18-per cent mash. The mortality or loss was practically the same. This was a normal reduction expected in the flock owing to culling and deaths.

1937-38 Trial—Rhode Island Reds

On Nov. 1, 1937 two pens of Rhode Island Reds pullets of 100 each were used. Corn and oats were used as grain and kept before the birds continuously in feeders. Oyster shell and ground bone were kept before the birds at all times. The mashes were as follows:

Laying Mash		High-Protein Mash or Supplement	
Ground yellow corn	20.0	Ground oats	8.0
Ground oats	15.0	Flour middlings	8.0
Wheat bran	16.0	Wheat bran	9.0
Flour middlings	16.0	Alfalfa meal (dehydrated).....	20.0
Alfalfa meal (dehydrated).....	10.0	Soybean oil meal	12.0
Soybean oil meal	5.0	White fish meal	12.0
White fish meal	5.0	Meat scraps	15.0
Meat scraps	5.0	Dried skim milk	12.0
Dried skim milk	6.0	Vit. D supplement (400D).....	2.0
Vit. D supplement (400D).....	1.0	Salt	2.0
Salt	1.0		

The laying mash would be an 18-per cent protein carrier and the supplement a 28-per cent protein carrier under the usual commercial guarantee.

Table 3. Feed consumption per bird.

	Corn		Oats		Mash		Shell		Bone		Total	
	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7
Nov....	4 718	4 352	.402	.654	910	653	.005	.083	.221	.281	6 346	6.023
Dec....	5.359	4 801	1.946	2.153	.924	1 279	.160	.183	.234	.208	8 623	8 624
Jan....	4.416	4 444	2 468	2 501	.980	1 275	.187	.208	.177	.214	8 237	8.732
Feb....	4 851	3 834	1.908	2 085	1 009	1 166	.163	.166	.128	.137	8 149	7 388
Mar....	5.309	4 577	1 681	1 954	1 273	1 338	.230	.261	.135	.120	8 628	8 250
Apr....	5 497	4 810	1.654	2 059	1 138	1 229	.145	.189	.120	.135	8 554	8 422
May....	5 279	5 148	1 713	2 218	1 277	1 417	.203	.218	.039	.123	8 601	9 124
June....	4 517	4 260	2 214	2 636	.969	1 157	.224	.188	.029	.111	7 953	8.352
July....	3 561	3 695	2 301	2 867	.902	1 419	.094	.124	.041	.049	6 899	8 154
Aug....	3 001	3.103	2.763	2 706	.871	1 406	.145	.204	.016	.788	6 797	8.207
Total ..	46.508	43.024	19.050	21.923	10 352	12 339	1 736	1 824	1.140	2.166	78.786	81.276

Results

Tables 3 and 4 give the results of the trial. Pen 3 received the supplement or high-protein mash and pen 7 received the normal mash.

No attempt was made in this trial to adjust the vitamin D intake with the result that with twice as much vitamin D supplement in the high-protein mash and only a slight decrease in the amount of mash consumed (approximately 2 lb.), pen 3 received more vitamin D. Egg production during the winter months was considerably better in pen 3 than pen 7. This might be explained because pen 7 did not receive an optimum amount of vitamin D.

Total feed consumption was about 2.5 pounds per bird less on the supplement fed birds.

The difference in total egg production was only 2.2 per cent in favor of the supplement fed birds. The loss by death was approximately the same. The decrease in the flock was normal over the period of 10 months.

Table 4. Egg production and mortality.

	Number Eggs		Per cent Production		Eggs per Bird		Deaths	
	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7	Pen 3	Pen 7
Nov.....	828	654	31.85	25.41	8 28	6.61	0	0
Dec.....	1,271	1,217	41.31	39.76	12 81	12 33	1	1
Jan.....	1,327	1,190	43.24	29.55	13.40	12.26	0	1
Feb.....	1,014	809	37.09	30.82	10.39	8.63	3	7
Mar.....	1,688	1,395	59.90	52.86	18.57	16.39	9	8
Apr.....	1,550	1,410	60.95	59.00	18.29	17.70	3	4
May.....	1,468	1,284	57.08	54.34	17.69	16.85	2	4
June.....	1,322	1,104	54.14	51.35	16.24	15.41	1	3
July.....	954	926	39.42	43.60	12.22	13.52	9	4
Aug.....	445	655	27.33	32.00	8.47	9.92	2	1
Total.....	11,867	10,644	44.83	42.61	136.36	129.62	30	33

Discussion

The results obtained from these trials indicate that there is a possibility of utilizing home-grown grains to a better advantage by using a high-protein mash where the quantity raised is in excess of the farm requirements.

The use of a supplement or high-protein mash increases the problem of supplying some of the needed vitamins for certain requirements. Usually it is largely a matter of supplying vitamin D. This could be solved by feeding a wet mash to which could be added the required amount of vitamin D to meet the requirements of the flock, whether for egg production or hatchability.

The use of some vegetable protein sources to produce a high-protein supplement might further reduce egg production unless careful attention was paid to adequate mineral and vitamin supplementation.

Since there is a decided difference in appearance and probably in acceptance by the animal, such a management procedure should be started before egg production begins, although in these trials many of the pullets were in production when they were placed on the ration. In the case of the Leghorns, there was a marked reduction in egg production following the change while in the Rhode Island Reds there was an increase. These breeds differ of course in other respects so that it is not unreasonable to expect that their reaction in this point would be different.

Another trial just completed indicates that the use of a wet mash to which the vitamin D supplement is added in the proper amount, gives better results and eliminates the difficulty in supplying adequate amounts of essential nutrients.

TRACTOR COSTS IN MICHIGAN, 1938

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SECTION OF FARM MANAGEMENT

Forty-five farmers in Michigan, operating 46 tractors, cooperated with the Farm Management Department in a study of tractor costs in 1938. These men kept records of their cash operating expenses, as well as the fixed charges for depreciation, interest, and shelter on their individual tractors. They kept a record of the hours used for all operations, including belt, drawbar, and custom work. As well as keeping the tractor record, these men also were cooperators in the Farm Accounting Project of the Farm Management Department. It was, therefore, possible to get information on the acreage and production of the various crops, the number and production of the various kinds of livestock, and the receipts and expenses of operating each co-operator's farm.

The 46 tractors used in this study were located on farms throughout Michigan, but primarily in the southern part of the Lower Peninsula, where crop farming is the most prevalent.

One-plow Tractor Costs

Nearly a third of the tractors in this study were of the one-plow size, which is a much larger proportion of the total than has been included in a similar study in previous years. These 15 one-plow tractors were nearly two years old at the beginning of 1938 and were each worth an average of \$619 at that time. They were used principally for drawbar work, and custom work accounted for only 37 hours per tractor, or about 9 per cent of the total. The operating expenses on these tractors were nearly \$100 for the year, with the fixed charges amounting to \$127; thus, the cost of using these tractors in 1938 was about 53 cents an hour, about 57 per cent fixed and 43 per cent operating expenses. This was a higher hourly cost than for a similar group of tractors in 1937 when they were used somewhat more than in 1938.

Two-plow Tractor Costs

The general-purpose two-plow tractors averaged about 2.5 years old and were used about 19 per cent more than the one-plow size. The yearly cost for 509 hours of use was \$290; 57 per cent for operating expenses and 43 per cent for fixed charges. This amounted to 56

Table 1. Relation of size of tractors to their yearly and hourly costs in Michigan, 1938.

Size of Tractor	1-plow	2-plow	3-plow
Number of Tractors	15	27	4
Tractor age (years)	1.0	4.2	1.3
Tractor value.	\$619	\$626	\$1,004
Hours use in year:			
Drawbar.	402	390	347
Belt.	26	44	57
Total.	428	434	404
Custom.	37	52	97
Yearly costs:			
Operating costs—			
Fuel.	\$71.12	\$98.30	\$66.16
Oil.	10.29	12.12	22.13
Repairs.	9.14	27.71	2.29
Labor (chores).	6.87	5.79	5.78
Auto use. . . . .	.26	.80	.....
Total.	\$97.68	\$144.72	\$96.36
Fixed costs—			
Depreciation.	86.17	56.93	68.13
Interest.	34.71	36.40	54.30
Shelter.	6.00	5.80	6.75
Total.	\$126.88	\$99.13	\$129.18
Total yearly costs.	\$224.56	\$243.85	\$225.54
Hourly costs:			
Operating (cents).	23	33	24
Fixed (cents).	30	23	32
Total Hourly Costs (cents).	53	56	56
Fuel for 10 hours (gal.).	12.7	17.1	17.3
Oil for 10 hours (qt.).. . . .	1.5	1.5	3.4

cents an hour, which was slightly less than for any of the four preceding years when such a study was conducted.

The standard type, two-plow tractors were older, lower valued, and were used less than any other group in this study. They were used approximately 341 hours during the year, at an average cost of 55 cents an hour. Fixed charges amounted to only \$66, owing to the small depreciation and interest charges on the old, low-valued tractors. The average cost per hour of work for all two-plow tractors was 56 cents (Table 1).

In 1938 the average cost of fuel for all the two-plow tractors was 23 cents an hour or about 40 per cent of the total cost, with depreciation coming next with 23 per cent (Table 2). About 57 per cent of the cost was cash outlay and the remainder was non-cash items.

Table 2. Distribution of cost items on 27 two-plow tractors on Michigan farms, 1938.

Items	Hourly cost	Per cent of total cost
	(cents)	
Fuel	22 6	40
Depreciation	13 1	23
Interest	8 4	15
Repairs	6 4	12
Lubricants	2 8	5
Other items	2 9	5
Total	56 2	

Three-plow Tractor Costs

Figures were kept and summarized on only four tractors of this size, which averaged only slightly more than one year old at the beginning of the year. They were used an average of 404 hours during the year, with belt work making up 57 hours of that amount. Operating expenses amounted to about \$96 a tractor, and fixed charges about \$129. The hourly operating expenses were 24 cents, with fixed charges amounting to 32 cents. Thus, the total hourly cost of 56 cents was the same as the two-plow tractor cost, although the depreciation and interest charges on the larger tractors were much higher than on the two-plow tractors because they were newer and more valuable machines.

Kinds and Amounts of Fuel Used

The amount of fuel used averaged 1.3 gallons per hour for the one-plow tractors, and 1.7 gallons for both the two-plow and three-plow tractors. In the case of the one-plow tractors, 77 per cent of the fuel used was gasoline, 54 per cent of that used in the two-plow tractors was gasoline, while distillate was the most common fuel used in the three-plow tractors. Only 2 per cent of the fuel used in the two-plow tractors was kerosene, which was the only group of tractors using any kerosene at all.

Tractor Use by Operations

It was found in this study that the one-plow tractors were used 94 per cent of the time for drawbar use, which was made up primarily of the operations carried on in seedbed preparation and for miscel-

laneous purposes. About 90 per cent of the two-plow tractor work was on drawbar jobs, with plowing and dragging the most important single operations. The belt work was divided between five different jobs, the most important of which were threshing and silo filling. The three-plow tractors were used 86 per cent of the time for drawbar work, and 14 per cent on belt. Seedbed preparation and miscellaneous jobs were not nearly as large a percentage of the total as in the case of the one- and two-plow tractors.

Size of Tractor in Relation to Labor and Power Costs

Farms on which one-plow tractors were used averaged 145 acres in size, while those using two-plow tractors averaged 185 acres. Too few three-plow tractor records were available to conclude anything regarding the size of farm on which they were used. About 50 per cent of the acreage on the one-plow tractor farms was cropland, while over 65 per cent was cropland on the two-plow farms. The two groups of farms were carrying approximately the same amount of productive livestock.

The charge for horse and tractor work averaged \$4.05 per crop acre on the one-plow tractor farms, and \$3.42 on the larger, two-plow tractor farms, or about 16 per cent less on the latter. The total labor and power cost per crop acre was only about 9 per cent less than for the two-plow tractor farms, owing to the lower labor charge per crop acre, which composed about three-fourths of the total. There was a little difference in the cost of a day's productive work, with the two-plow farms being about 4 per cent cheaper.

Hours Tractor Use and Tractor Costs

Tractor use on these farms ranged from 98 to 1,349 hours per tractor. The number of hours that a tractor is used during a year has a direct influence on the total tractor cost and upon the cost per hour of use. Ten of the two-plow tractors were used fewer than 250 hours, averaging 172. The total cost for the year for this group of 10 tractors was about \$153 a tractor, or 89 cents an hour (Table 3). Tractors used in this group had a higher hourly cost, which would have been still higher had the tractors not been so old (6.6 years), making the fixed charges low. The fixed charge per hour, however, was much higher than for the other groups, owing to the few hours the tractors were used.

Eight of the two-plow tractors were used more than 550 hours, averaging 758 hours for the year, or more than four times as much as the low-use group. The total tractor cost was \$372, or only a little more than twice the cost of the group used only 172 hours. This makes the hourly cost only 48 cents as compared to 89 cents for the low-use group. Increased tractor use makes for increased total costs, but decreased hourly costs.

The tractors were used much more for custom work on the high-use group than on the low-use group. The income from the tractor's share of the custom work reduced the total tractor cost \$2 on the low-use group, and \$147 on the high-use group. This reduced the cost per hour of work on the operator's own farm a negligible amount on the low-use

Table 3. Influence of hours of use on two-plow tractor costs in Michigan, 1938.

Hours use in year (range).....	0-250	251-550	551-up
Number of tractors.....	10	9	8
Hours use in year:			
Drawbar.....	159	398	668
Belt.....	13	23	108
Total.....	172	421	776
Custom.....	3	13	157
Yearly costs:			
Operating.....	\$87	\$125	\$226
Fixed.....	66	105	146
Total.....	\$153	\$230	\$372
Net cost to own farm ..	\$151	\$209	\$225
Hourly costs:			
Operating (cents) ..	51	30	29
Fixed (cents) ..	38	25	19
Total ..	89	55	48

group, but 12 cents on the high-use group which did considerable custom work. It is clear that some farmers can do considerable custom work to reduce their own net tractor costs, but they must be sure that they do not lower the income on their entire farm while doing it.

Influence of Size of Farm

The farms on which these tractor records were kept were divided into three groups, based on size of farm. The 18 small farms averaged 79 acres, the 15 medium-sized farms 153 acres, and the 13 large farms 325 acres. The largest farms had a smaller percentage of their acreage in crops, but relatively the same amount of livestock per crop acre (Table 4).

The tractors on the largest farms were used considerably more than those on the smallest farms, and much of the large farm use was belt work. The large farms had more than three times as many crop acres as did the small farms, but only 120 per cent more horses, 70 per cent more man labor, and 58 per cent more hours of tractor use. The use of a tractor on a large, extensive farm increases labor efficiency more than on a small, intensive farm, because the labor on extensive crops can, by introduction of a tractor, be reduced more than on intensive crops and livestock.

The charge for man labor, including an allowance for the operator and his family, as well as cash paid hired help, was the prominent item in the total labor and power cost, comprising 78 per cent of the total on the small farms and 74 per cent on the large. The labor charge per crop acre was \$17.24 on the small farms, and \$7.74, or about 55 per cent less, on the large farms.

The total labor and power cost per crop acre was \$22.40 on the 79-acre farms and only \$10.41, or about 54 per cent less, on the 325-acre farms.

The comparison of total costs per crop acre is not fair unless the intensity of operations is considered. This was found by determining

Table 4. Relation of size of farm to labor and power costs on 46 Michigan tractors, 1938.

Acres in farm, total (range).....	0-119	120-199	200-up
Number of farms.....	18	15	13
Farm organization:			
Acres in farm, average.....	79	153	325
Crop acres per farm.....	58	90	187
Productive animal units.....	13	24	41
Number of men, average.....	1.7	2.0	2.9
Number of horses, average.....	1.4	2.1	3.1
Days productive work, total.....	417	491	733
Days productive work per crop acre.....	7.0	5.4	4.0
Days productive work, per man.....	243	250	267
Labor and power costs:			
Man labor (own, family, hired).....	\$1,000	\$1,060	\$1,448
Horse work (\$90.00 per horse).....	126	180	279
Net tractor cost (custom income deducted).....	173	178	220
Total cost per farm.....	\$1,299	\$1,427	\$1,947
Cost per crop acre.....	\$22.40	\$15.86	\$10.41
Cost per day productive work.....	\$3.14	\$2.91	\$2.66

the days of productive work on the farm and figuring the cost on that basis. It was shown that labor and power costs amounted to \$3.14 per day of productive labor on the small farms and \$2.66, or 14 per cent less on the large farms, indicating a 14-per cent more efficient use of labor and power on the large farms.

THE INFLUENCE OF NEUTRALIZERS UPON THE ACIDITY OF BUTTER AND BUTTERFAT

I. A. GOULD AND R. C. TOWNLEY
SECTION OF DAIRYING

The practice of partially reducing the acidity of cream which is to be manufactured into butter by the use of approved neutralizers is now almost universally accepted. This so-called "neutralization" of cream for buttermaking has naturally resulted since the bulk of cream used for buttermaking is sour, and since investigations and experience have shown that such cream cannot be processed without having a detrimental effect upon the flavor and keeping quality of the butter and upon the fat losses in the buttermilk.

During recent years renewed interest has been aroused in neutralization of cream, since research work has shown the need for careful control of the process if the maximum advantages attributed to it are to be obtained. Among other things, this careful control of neutralization necessarily implies the accurate standardization of the acidity and pH of the cream and butter.

Although the major portion of the studies dealing with the acidity in butter has been based on pH values, some data have been presented dealing with the titratable acidity of butter and butterfat. Hunziker

(5) found the acidity of butter from sour, neutralized cream and from sweet cream to have titratable values (expressed as lactic acid) of approximately 0.03 — 0.06 per cent. The pasteurization temperature was a factor influencing the titratable acidity; the higher the pasteurization temperature the lower the acidity of the butter. Nissen (6) reports similar values, with cream of about 0.15 per cent acidity giving butter acidities of 0.02 — 0.04 per cent, and cream of about 0.25 per cent acidity giving butter acidities of 0.03-0.05 per cent. The titration values of these two workers were obtained by titration of aqueous mixtures; such values being lower than would be secured by titration of an alcohol mixture of the fat.

Bendixen (2) presents the following data:

Sweet Cream Butter

	Acidity in Butter	Acidity in Butterfat
Maximum	0.130	0.113
Minimum	0.070	0.038
Average	0.095	0.067

Neutralized Cream Butter

	Acidity in Butter	Acidity in Butterfat
Maximum	0.178	0.129
Minimum	0.072	0.038
Average	0.122	0.084

These data were obtained by titration of an alcohol mixture of fat; consequently they are considerably above the values reported by Hunziker (5) and Nissen (6). The end-point of the butter titration in alcohol as reported by Bendixen was usually within the pH range of 7.8-7.95 as contrasted to the range of 7.33-7.73 observed by Nissen for aqueous titrations. This higher end-point is a contributing factor in causing higher titers for the alcohol mixture. In addition, Bendixen (2) points out that the release of fatty acids in the alcohol may be involved.

Bendixen (2) concludes that the acid values of all types of butter would not be absolutely comparable since lactic acid and salt tend to depress these values and alcohol and oleic acid tend to increase the values. These variable results are due to changes in the phenolphthalein end-point. The obscuring of the end-point by highly colored butter is also a factor in this connection.

The influence of different neutralizers and of different ranges of neutralization on the acidity of the butter and butterfat has been studied only to a limited extent. Bird, Fabricius, and Breazeale (3) report that the titratable acidity of the fat of butter "progressively decreases with increases in the pH of cream."

Scope of Investigations

The purpose of this study was to determine the influence of different neutralizers and of different ranges of neutralization upon the acidity of the butter and butterfat.

Procedure

The cream used for this experiment tested approximately 35 per cent fat and 0.5 per cent acidity. The neutralization, pasteurization, and churning was conducted according to standard commercial practices. The pasteurization temperature was 145° F. for 30 minutes.

Six neutralizers were utilized; three trials being completed for each neutralizer. The neutralizers were sodium carbonate, Recto, Wyandotte C.A.S., caustic soda, calcium hydrated lime, and magnesium oxide lime. In each trial, the acidity of the cream was calculated to be reduced to 0.25, 0.15, 0.10, 0.05, and 0.0 per cent.

The butter was standardized to contain 2.5 per cent salt and 16.5 per cent moisture. Following churning, samples of butter were obtained for the acidity determinations. The determinations were conducted by weighing out 20 grams of the butter and adding 50 ml. of neutral alcohol. The alcohol-butter mixture was heated to boiling on a hot plate, shaken well, and phenolphthalein solution added. The mixture was then titrated to a pink end-point, permanent for one minute, with N/10 NaOH. This is the official method for determining free fatty acids (1).

Pure butterfat was obtained by melting the butter, and centrifuging it in large test tubes in a Babcock centrifuge. The fat was then filtered to remove the last traces of water and curd. Acidity determinations of the fat were conducted in the same manner as were those for the butter.

Results

The influence of different neutralizers and of different degrees of acid reduction is shown by the data in Table 1.

This table shows the acidity of the butter to decrease with successive reductions in the acidity of the cream. This was true irrespective of the neutralizer used. The average results show the approximate values one might obtain when any neutralizer is calculated to reduce the acidity of the cream throughout the range of 0.25-0.0 per cent. The individual values show the following ranges in butter acidity were obtained at the different levels of neutralization: 0.11-0.13 at 0.25 per

Table 1. The influence of neutralizers upon the acidity of butter.*

Neutralizer	Acidity Desired in Cream				
	0.25	0.15	0.10	0.05	0.00
Sodium carbonate	0.112	0.100	0.091	0.086	0.077
Recto	0.124	0.113	0.104	0.091	0.073
Wyandotte C. A. S.	0.120	0.106	0.092	0.084	0.069
Caustic soda	0.115	0.102	0.078	0.069	0.050
Calcium lime	0.130	0.119	0.113	0.094	0.060
Magnesium lime	0.131	0.126	0.109	0.098	0.078
Average	0.122	0.111	0.098	0.087	0.069

*All values in per cent acidity calculated as lactic acid.

cent, 0.10-0.13 at 0.15 per cent, 0.08-0.11 at 0.10 per cent, 0.07-0.10 at 0.05 per cent, and 0.05-0.08 at 0.0 per cent.

In general, the limes were less efficient in reducing the acidity of the butter than were the other neutralizers, at least throughout the calculated neutralization range of 0.25-0.05 per cent. The caustic soda, however, appeared to be the most efficient in this connection throughout the entire range studied.

The effect of the neutralizers upon the acidity of the butterfat is shown by the results in Table 2. These data show, in general, the same trend as observed in the case of the butter: The lower the point of neutralization of the acidity in the cream, the lower the acidity in the butterfat. As may be noted, the fat acidity values are decidedly lower than the butter values in every case with the exception perhaps of the calcium lime values at the higher acidity ranges.

Table 2. The influence of neutralizers upon the acidity of butterfat.*

Neutralizer	Acidity Desired in Cream				
	0.25	0.15	0.10	0.05	0.00
Sodium carbonate	0.079	0.074	0.072	0.071	0.058
Recto	0.088	0.072	0.063	0.063	0.055
Wyandotte C. A. S.	0.088	0.075	0.071	0.066	0.059
Caustic soda	0.086	0.063	0.056	0.045	0.032
Calcium lime	0.122	0.113	0.097	0.065	0.041
Magnesium lime	0.098	0.092	0.075	0.055	0.038
Average	0.094	0.082	0.072	0.061	0.047

*All values in per cent acidity calculated as lactic acid.

Again, as in the case of the butter, the limes were less efficient than the other neutralizers in lowering the fat acidity at the higher acidity values. This was especially true of the calcium lime. In contrast, the caustic soda was slightly more efficient than the carbonate neutralizers in lowering the fat acidity between the neutralization range of 0.15-0.0 per cent. The average results illustrate the approximate fat values one might expect at the different calculated acidity ranges.

When the acidity desired in the cream was 0.25 per cent, the acidity values of the fat ranged from approximately 0.12 to 0.079, as contrasted to a range of 0.097-0.056 at the 0.10 per cent acidity level, and to 0.059-0.032 at the 0.0 per cent acidity level.

Discussion

The results obtained in this study illustrate the necessity for one to consider the degree of neutralization and the type of neutralizer when presenting data dealing with butter and butterfat acidities of neutralized butter. In general, the lower the extent of the neutralization the lower the acid values for the butter and butterfat. However, the differences in the efficiencies of neutralizers to lower these acid values are sufficiently important to be carefully considered.

The lower values obtained in the case of the fat as contrasted with the butter values are not unexpected. In the butter, the milk-solids-not-fat present, i.e., the curd, would combine with some of the alkali used in titration, thus increasing the titer.

A comparison of acid values of butter and butterfat is illustrated by Fig. 1. This figure shows the acidities when caustic soda and calcium lime were used. Since caustic soda was the most efficient in

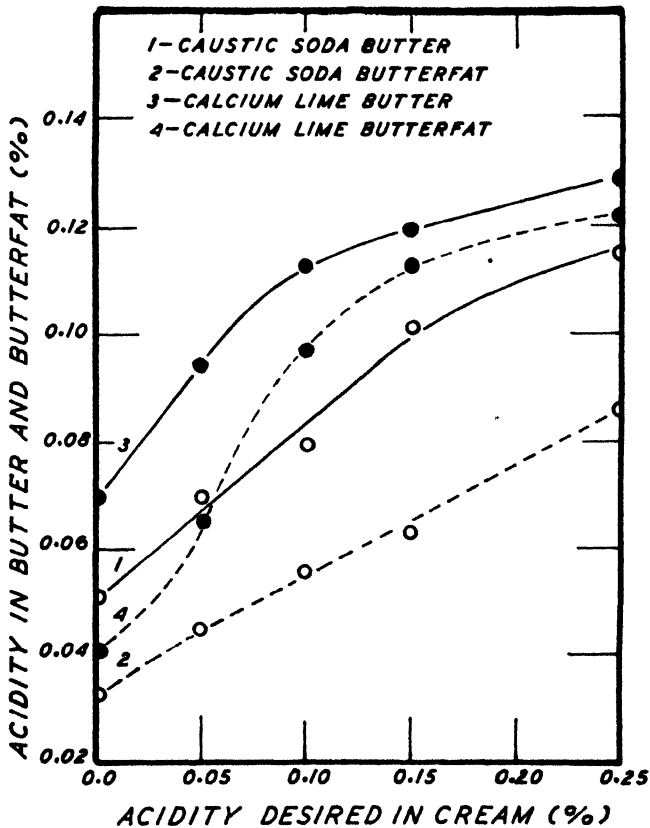


Fig. 1. Acid values for butter and butterfat when caustic soda and calcium lime were used to neutralize the cream to different acidities.

lowering the acid values and lime the least efficient, the figure shows the extremes one might expect. The graph shows that the caustic soda acid reductions are more linear than those of the lime. In addition, it shows the differences between the butter and butterfat acidities which occur at different acidity levels with these two neutralizers. The relatively high acid values of the butterfat from the calcium neutralized cream at the higher acidity ranges is of especial interest in this connection.

Summary and Conclusions

Progressive lowering of the acidity of cream by the use of different neutralizers results in a corresponding lowering of the acidity of the butter and butterfat obtained from this cream.

All neutralizers were not equally efficient in lowering the acidity of the butter and butterfat, with the limes being less efficient than the soda neutralizers.

As was expected, the acidity of the butterfat was lower than the acidity of the butter. However, the extent of the difference between the butter and butterfat acid values varies somewhat with the type and amount of neutralizer used.

These results show the necessity of considering the type of neutralizer and the degree of neutralization in connection with acid values of the butter and butterfat.

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LIPASE ACTION IN MIXTURES OF RAW AND PASTEURIZED HOMOGENIZED MILK

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Speculation has arisen as to whether the lipolytic activity of raw homogenized milk will bring about additional splitting of the fat in pasteurized milk. Pfeffer, Jackson, and Weckel (2) found a slight difference in the titration values of homogenized and unhomogenized substrates when untreated milk was added. They concluded from this that the increased lipolytic activity of raw homogenized milk was not due entirely to a decrease in the size of the fat globules.

The purpose of this study was to determine if and to what extent the lipase of raw homogenized milk would exert its action on similar milk unhomogenized. Two methods were employed. One method was based on the increase in the titration values of the unhomogenized milk

to which was added different quantities of homogenized raw milk. The second was based on "selective separation" and "differential churning" of fat from cream obtained from a mixture of homogenized raw and unhomogenized pasteurized milk. Previous work (3) had shown the extent to which fat separation and churning might be expected under various pressures of homogenization. This study showed separation of milk homogenized (viscolized) at 2500 and 3500 pounds pressure resulted in recovery of 53 and 36 per cent of the fat, respectively.

In connection with the differential churning, the assumption is made that in the churning of cream from mixed homogenized-unhomogenized milk, the fat from the unhomogenized portion, being present in greater amount and in its natural state, should churn out fairly easily, leaving the larger percentage of the fat from the homogenized portion in the buttermilk. The use of 3000 pounds homogenization pressure would appear sufficient to stabilize the fat in the homogenized portion against churning. Therefore, if this assumption holds, then the titration values of the fat obtained would show whether the unhomogenized fat had undergone any hydrolysis. However, it is realized that such an assumption is subject to modification: for example, when the homogenized fat is churned with unhomogenized fat its stability against churning may be appreciably decreased. Nevertheless, this assumption is made with a full realization of its limitations.

Procedure

Changes in Titratable Acidity of Milk—Raw and pasteurized milk were homogenized (viscolized) at 3000 pounds pressure, the pasteurization exposure being 145-150° F. for 30 minutes prior to homogenization. Following homogenization, the pasteurized milk was mixed with different quantities of the raw milk. The proportions of raw homogenized milk were 10, 20, 30, 40, and 50 per cent of the pasteurized milk. Titratable acidity determinations were made at once and after storing the milk at 35-40° F. for 12, 24, 48, 72, and 96 hours. These determinations were conducted using phenolphthalein as the indicator and titrating with N/10 NaOH. The results were expressed as percentage of lactic acid.

Differential Churning—Raw milk homogenized at 3000 pounds pressure was mixed with an equal volume of unhomogenized pasteurized milk and stored at 35-40° F. Samples of milk were secured after 0, 48, and 96 hours and pasteurized at 145-150° F. for 30 minutes in order to inhibit any further lipolytic action. The milk was then separated and the cream churned. The fat was purified by melting, centrifuging, and filtering. The titration of the free fatty acids in the fat was conducted by the A.O.A.C. method (1).

Results

Acidity Changes in Milk—The increases in titratable acidity obtained when homogenized raw milk was mixed with homogenized pasteurized milk in different proportions, and the mixed milk stored for various periods, are presented in Table 1. The values are given as increases in acidity percentage over the 0-hour samples. Consequently, the 0-hour values are arbitrarily placed at zero.

Table 1. Increases in the titratable acidity of homogenized pasteurized milk when mixed with different proportions of homogenized raw milk.
(Av. 5 trials)

Nature of Sample		Increases in titratable acidity* after					
		0 hrs.	12 hrs.	24 hrs.	48 hrs.	72 hrs.	96 hrs.
		per cent	per cent	per cent	per cent	per cent	per cent
Raw milk:							
Unhomogenized.....		0 00	0 004	0 005	0 006	0 006	0 008
Homogenized.....		0 00	0 030	0 038	0 048	0 060	0 072
Pasteurized milk:							
Homogenized.....		0 00	0 000	0 000	0 000	0 000	0 000
Mixed milk:							
Per cent of							
Homo. raw	Unhomo pasteurized						
10	90	0 00	0 005	0 008	0 011	0 019	0 025
20	80	0 00	0 007	0 011	0 013	0 023	0 029
30	70	0 00	0 014	0 021	0 029	0 041	0 047
40	60	0 00	0 014	0 021	0 030	0 040	0 050
50	50	0 00	0 014	0 021	0 032	0 040	0 051

*Calculated as lactic acid

The results presented in this table show increases in acidity to occur in all of the pasteurized samples to which the homogenized raw milk was added, the increases being numerically greater with larger increments of the homogenized raw milk. However, there was not a uniform relationship between the increases in acidity and the percentage increases of the raw milk. The values obtained when 30, 40, and 50 per cent raw milk were used were practically identical throughout the storage period.

If the lipase action is limited to the raw milk and is due primarily to changes in the size of the fat globules, the increases in acidity which occur in the samples would seem to be directly proportional to the amount of raw milk used. In other words, increments of pasteurized milk would seem to have a retarding effect on the lipolysis of the homogenized fat in the pasteurized-raw milk mixture; the greater the amount of pasteurized milk the greater the dilution of retardation effect. However, analysis of the data shows the titration values to be somewhat higher than they would be if the lipolytic action were limited to the raw milk alone. For example, if lipolysis were limited to the homogenized fat only and if the fat of the raw milk mixed with that of the pasteurized milk underwent the same degree of lipolysis as did that of the control homogenized raw milk, then the acidity increase in the sample containing 10 per cent raw milk should be approximately 10 per cent as great as that in the 100 per cent raw milk; the acidity increase in the 50 per cent raw milk sample should be 50 per cent as great as that in the 100 per cent raw milk, and so on. The results show, however, that the actual acidity increases are above the calculated values. This is illustrated in Fig. 1.

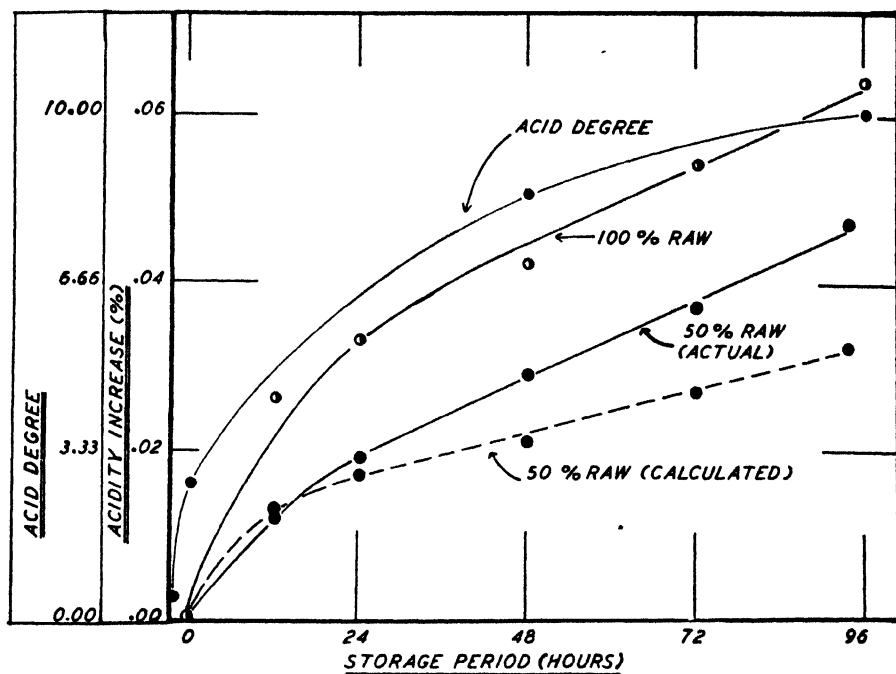


Fig. 1. Lipolysis in mixed homogenized-unhomogenized raw milk. (Acid degree defined as the number of milliliters of N/1 NaOH to neutralize the free fatty acids in 100 grams of fat.)

Regarding acidity changes, the graph in Fig. 1 shows the acidity increase expected if no lipase action occurred on the pasteurized milk fat, and, also, the acidity values actually obtained. The values are based on a 50-50 mixture of the raw and pasteurized milk. The homogenized raw milk values were corrected to compensate for the slight increase in acidity noted in the unhomogenized raw milk. This graph illustrates the fact that a certain amount of fat splitting has likely taken place in the pasteurized portion of the mixed milk to account for this extra amount of acidity.

Acid Degree of Fat Churned from Mixture of Unhomogenized and Homogenized Milk—The acid degrees of fat obtained by churning a 50-50 mixture of homogenized raw and unhomogenized pasteurized milk are also shown in Fig. 1. These acid values are not for the fat of the same milk on which the titration values were obtained, but of different lots similarly treated.

The data seem to furnish further evidence that lipolysis occurs to some extent in the unhomogenized pasteurized portion of the milk. However, that the increases in these fat titration values were not due entirely to the fat splitting in the unhomogenized portion is shown by the fact that a marked increase in the acid degree of the fat was noted when the raw and the homogenized milk were mixed, separated, and churned immediately. The milk fat in the unhomogenized portion had an original acid degree of 0.42, whereas the acid degree of the fat ob-

tained immediately from the 50-per cent raw milk mixture was increased to 2.66. This immediate change in fat acidity would seem to indicate that the churning procedure removes a portion of the homogenized fat as well as the unhomogenized. Consequently, the increases in acid degree of the churned fat which were observed at the end of the 48-hour and 96-hour storage periods may be only partially due to the lipolysis of the unhomogenized fat.

Summary and Conclusions

When homogenized pasteurized milk is mixed with homogenized raw milk and the mixed milk stored, the increases in acidity obtained are greater than the calculated values if only the raw product undergoes lipolysis. This would seem to indicate that the fat in the pasteurized milk is also being split to some extent by the lipase action.

The titration of pure fat obtained by churning a mixture of homogenized raw and unhomogenized pasteurized milk stored for various periods shows that such fat has undergone appreciable lipolysis. Indications are that this fat comes both from the homogenized and from the unhomogenized portion of the milk.

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THE INFLUENCE OF SOME GROUND COVER TYPES UPON TREE SEEDLING SURVIVAL

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SECTION OF FORESTRY

It has long been recognized by foresters that indicator plants furnish a valuable method of identifying and classifying sites for reforestation purposes. They offer evidence regarding soil type, soil moisture, drainage, aeration, fertility and other factors which determine the success of reforestation projects. By merely noting their presence, absence or abundance, it is often possible for the forester to predict the probable success or failure of a reforestation program, or to recommend the species of trees to be planted. In some cases they may be used to predict growth and yield.

The role of indicator plants in evaluating forest planting sites has been studied by Zon (1915), Korstian (1917), Tillotson (1918), Wilde (1933), Heimburger (1933), and others. All of these workers have found

definite relationships between the occurrence of certain plants and the suitability of the area for forest tree planting.

Three common cover types on abandoned fields or burned-over lands on the eastern part of the upper peninsula of Michigan are quack grass, *Agropyrum repens*; dewberry, *Rubus villosus*, and polytrichum moss, *Polytrichum sp.* To test the indicator value of these cover types a study was made of survival and growth of five species of forest trees seedlings at the Dunbar Forest Experiment Station near Sault Ste. Marie, Mich.

Procedure

One plot, 10 x 10 feet, was located in each of the three cover types in an old field plantation of white pine and red pine established in 1929. The soil is classified by the U. S. Bureau of Soils as Bruce fine sandy loam. Topography is nearly level but slight differences in elevation influence locally the degree of surface drainage. Each plot was planted in the fall of 1936 with 40 each of European larch, *Larix decidua*; white pine, *Pinus strobus*; red pine, *Pinus resinosa*; white spruce, *Picea glauca*; and jack pine, *Pinus banksiana*. Two-year-old seedling stock was used for all the species. Vegetation was clipped from each plot prior to planting but no further maintenance was given. Planting was by the slit method.

Tile was sunk to a depth of 36 inches adjacent to each plot for the purpose of recording water table levels. Survival and growth records were taken at the end of the growing seasons in 1937 and 1938.

Results

Survival and growth results for the three cover type plots are given in Table 1.

Table 1. Survival and growth of five species of forest tree seedlings on three different cover types.

Species	Survival Per cent						Growth in Inches		
	1937			1938			1938		
	Quack Grass	Poly-trichum moss	Dew-berry	Quack Grass	Poly-trichum moss	Dew-berry	Quack Grass	Poly-trichum moss	Dew-berry
White pine	10 0	15 0	75 0	7 5	12 5	67 5	1 7	0 9	2 1
Red pine	2 5	5 0	75 0	2 5	2 5	55 0	3 5	2 0	2 9
Jack pine	45 0	30 0	60 0	42 0	30 0	55 0	7 1	9 5	7 6
White spruce	17 5	10 0	82 5	15 0	7 5	67 5	1 8	1 4	1 6
European larch	10 0	22.5	95.0	10 0	22.5	87.5	5 6	5.4	7.1
All species	16.5	16 5	77.5	15 5	15.0	66.5	3.0	3.8	4.3

The dewberry cover type in all cases gave strikingly higher survival results than either the quack grass or polytrichum moss cover types, 66 per cent as compared to 15.5 and 15.0 per cent at the end of the second growing season. Only jack pine among the five species gave fair survival on the quack grass and polytrichum moss cover types.

Slight losses in survival occurred from 1937 to 1938, averaging for the quack grass type 1.0 per cent, for the moss type 1.5 per cent and

for the dewberry 11.0 per cent. The heavier loss in the dewberry type in the second year may be due to competition of the dewberry plants which after the clipping in 1936 had grown to good size in 1938 and were crowding the tree seedlings.

From the standpoint of growth, the dewberry type appears most favorable, the average growth rate of all species being greater than in the case of the other two types. White pine and European larch show best growth results on the dewberry type. Growth of red pine and white spruce is slightly better on the quack grass type than on the dewberry type. Only jack pine of the five species made best growth on the moss type, all other species making least growth on this type.

Water Table

Figure 1 gives the water table levels for the three types from early May to late October. While these data are for 1937, the 1938 data are very similar.

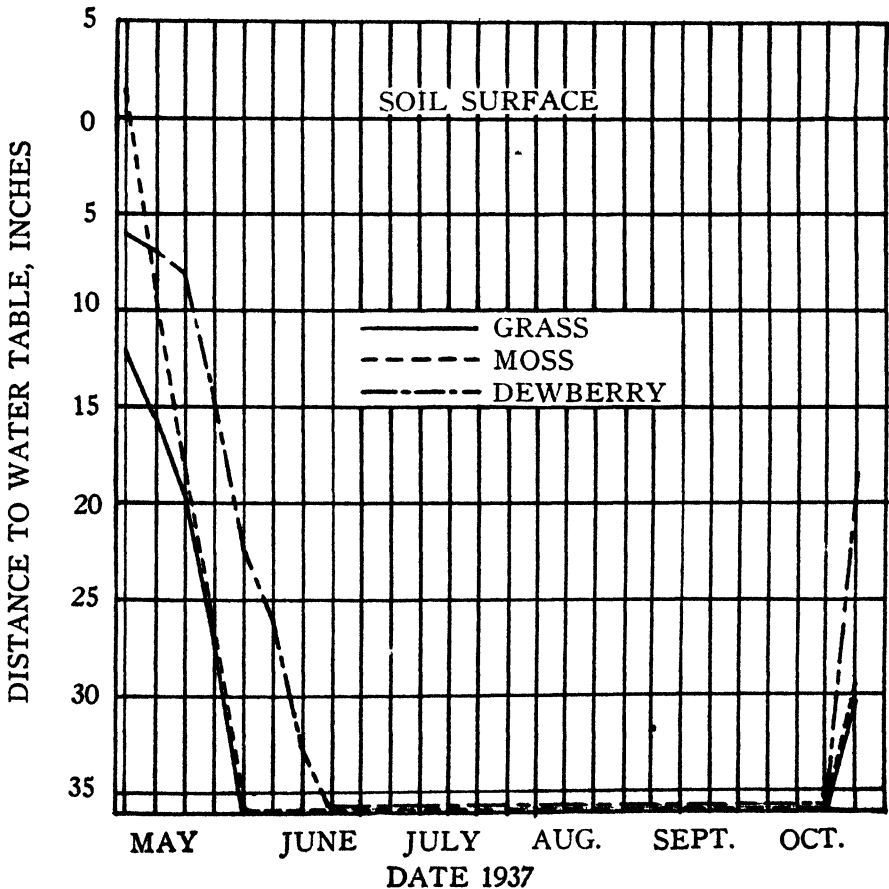


Fig. 1. Water table levels for three cover types during the growing season, 1937.

Results of water table measurements show that in May and early June water table levels were very high, there being 2 inches of surface water in the case of the moss type. In the quack grass and dewberry types the water table was from 4 to 8 inches from the surface in early spring during 1937 and 1938. It fell rapidly with the beginning of growth and by the end of June was below the 36-inch level in all three types. During late fall the water table began to rise but did not get higher than the 18-inch level before frost. It is notable, however, that while the water table in the dewberry type is between those of the quack grass and moss types in the spring it drops much more slowly. While the water table in moss and grass types dropped to the 36-inch level in five weeks, it took eight weeks to reach this level in the dewberry type. The dewberry type, therefore, would be more favorable than the moss type in providing better aeration in early spring and drying out less rapidly during the growing season.

The quack grass type has the lowest water table of the three types in early spring. In this type the water table dropped rapidly, reaching the 36-inch level about the same time that it was reached in the moss type.

Low survival in the moss type may be explained, in part at least, by the unfavorable soil moisture relations indicated by the high water table in early spring dropping rapidly to below the 36-inch level. The rapid drop of the water table in the moss type likewise may indicate unfavorable soil moisture conditions, similar to the conditions in the quack grass type. Competition from the quack grass undoubtedly was an important factor in the loss of trees and the moss also may be important in this respect.

Summary and Conclusions

A study of the indicator value of three common cover types for reforestation purposes was made at the Michigan State College Dunbar Forest Experiment Station, located near Sault Ste. Marie, Mich. The cover types studied were quack grass, polytrichum moss and dewberry, typical of many reforestation sites in the eastern part of the upper peninsula of Michigan.

Forty trees each of white pine, red pine, jack pine, white spruce and European larch were planted in each of the three plots, located one each in the three cover types.

The dewberry cover type was found to be the best of the three cover types in relation to both survival and growth of five conifer species. After two years the dewberry type averaged 66.5 per cent survival for all species compared to 15.5 per cent for the quack grass type and 15.0 per cent for the polytrichum moss type.

Growth averaged 4.3 inches during 1938 on the dewberry cover type compared to 3.9 inches on the quack grass type and 3.8 inches on the polytrichum moss type. Jack pine, however, made best growth on the polytrichum moss type while red pine and white spruce made somewhat better growth although very poor survival on the quack grass plot.

Site differences appear to be correlated with height of water table. The polytrichum moss type has a high water table in spring, often there is surface water. The water table recedes rapidly in this type

however and is below 36 inches by the end of June. The quack grass type is characterized by a lower water table in early spring, about 12 inches from the surface. The water table recedes rapidly, reaching the 36-inch level at about the same time it is reached in the moss type. The dewberry type in early spring has a fairly high water table, 5 inches from the surface. It recedes more slowly than in the moss or quack grass types, reaching the 36-inch level three weeks later.

The dewberry cover type indicates a much better planting site than either the quack grass or polytrichum moss cover types. The quack grass type should be favorable to tree growth once the trees are well established.

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THE BOYSENBERRY IN MICHIGAN: A PRELIMINARY REPORT

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SECTION OF HORTICULTURE

During the last two years unusual interest has been manifested by Michigan gardeners and fruit growers in the new boysenberry. This new berry was first introduced to the public by a California nurseryman in the spring of 1935, and since that time it has been well disseminated throughout the eastern United States. It was named the boysenberry in honor of Rudolph Boysen, who is said to have developed it by crossing the loganberry, raspberry and blackberry. However, the exact origin of the variety is probably not definitely known.

Since the introduction of the boysenberry it has been extensively advertised to stimulate the sale of plants and many statements have been made regarding the merits of the berry. However, no fruit is perfect in all respects, and it is the purpose of this article to acquaint the prospective grower with the faults as well as the good points of the variety. The following notes and suggestions for culture are based on the results of several years of experience in growing the boysenberry at East Lansing and at South Haven as well as observations on the behavior of the variety in other sections of the state.

In general, the growth of the boysenberry plant is similar to that of the common dewberry. The vines are trailing in habit, and, therefore, must be trained to some form of trellis or support. They are very

vigorous, the new shoots or first-year canes making a growth of 12 to 15 or 20 feet during the season. It is very productive. In winters when the vines are protected with a covering of snow they seem to be hardy, but in the colder sections of the state or in localities where the snowfall is light they should be mulched with straw or similar material or lightly covered with soil to prevent winter injury. The canes are beset with many large spines, which makes the harvesting of the fruit and the handling of the plants rather disagreeable.

The berries begin to ripen early in July and continue to ripen over a period of two or three weeks. They are very large, dark purple in color, juicy, with a rather tart, pleasing flavor. When well ripened, which is necessary to develop the best dessert quality, the fruit is rather soft and does not withstand shipping well. They make good jellies and pies and are one of the best berries for freezing purposes.

Suggestions for Culture

The best time to set the plants is early spring. They should be set as early as the ground can be worked, and the plants grow best in fertile well-drained loam soils. In the home garden the plants may be set as closely as 6 feet apart in the row, but in the commercial plantation they should be spaced at least 8 feet apart each way. The vines should be allowed to grow on the ground the first summer and the canes tied to a two-wire trellis, 4 or 5 feet high, before the leaf buds start to open in the spring. As the new canes grow during the summer they should be pushed back in line with the row to facilitate cultivation.

In the second-year after the crop has been harvested the old canes which have borne fruit should be cut off close to the ground and burned. The new canes should be allowed to grow on the ground until the following spring and tied to the trellis as before. The vines are susceptible to anthracnose and for that reason they should be sprayed each spring after the canes have been tied to the trellis, with 1:10 lime-sulphur solution.

If the vines are growing in fertile soil, no fertilizer may be necessary. Poor soils should be well enriched with poultry or barnyard manure. If manures are not available, the application of sulphate of ammonia or a ready mixed complete garden fertilizer at the rate of one-fourth to one-half pound per vine may be beneficial. During dry weather the vines should be well irrigated, if possible. The soil should be kept rather moist, especially during the picking season, if the best results are to be obtained.

The boysenberry can be recommended for the gardener who desires to grow enough fruit for home use. A half-dozen plants should be sufficient to supply an ordinary family with enough berries for canning, preserving, and table use. The extensive commercial planting of the variety in Michigan is not to be recommended. The market demand for the fresh fruit has not been well established, and the well ripened fruit is too soft for distant shipping. The chief outlets for the fruit at the present time are in the form of juice, or as frozen fruit for sale to commercial pie bakers, canners and preservers. Small trial plantings should be made to determine the value and desirability of the boysenberry in a given locality before attempting to grow it on a commercial basis for fruit production.

HEAVY EMERGENCY SPRAYING STOPS CODLING MOTH INCREASE

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The season of 1938 is remembered by apple growers as one in which a late frost (May 13) materially reduced and in some orchards eliminated the crop. The uncertainties concerning set on a planting of Northern Spy trees, following this frost, afforded opportunity for observation upon a question that has been discussed for years by growers and entomological workers; namely, is it possible to stop an infestation of codling moth after first brood larvae are beginning to enter the apples in numbers?

The information presented was collected as a result of inspection on July 4, 1938, which revealed that the Spy trees, forgotten insofar as crop prospects were concerned, had a crop averaging possibly 10 bushels per tree. Inasmuch as no further sprays had been applied after May 13, 1938, (calyx) the apples were heavily infested by codling moth.

Following these findings, on July 6 and 7 the planting was laid out in four series of three plots with four spray treatments of five applications each planned. This permitted triplication of plots with a better chance of valid findings. The first two sprays were applied July 7 and July 9. The three other subsequent sprays were applied at 10-day intervals thereafter.

It should be noticed that the first two sprays were applied within two days of each other. This was done to insure thorough coverage. Further insurance of thorough coverage was afforded by the application of excessive amounts of spray at these two times. Approximately 40 gallons of spray were applied in each of these initial applications for the trees were large and dense. Subsequent applications were at the usual rate of 15-18 gallons for trees of that size.

The four spray treatments, each in 100 gallons of water, were as follows:

1. Lead arsenate, 3 pounds.
2. Fixator (bentonite base), 4 pounds, plus 1 pint nicotine sulphate plus $\frac{1}{2}$ pint soy oil.
3. B. L. 155, 4 pounds, plus $\frac{1}{2}$ gallon summer oil emulsion.
4. Double strength 155, 2 pounds, plus 1 pint soy oil.

At the time the apples were sprayed, 3,000 apples were collected at random in the plots of each treatment and scored for codling moth injury. At harvest time, 3,000 apples from each treatment were again collected in the same way and scored for codling moth injury. The data thus accumulated are present for comparison in the ensuing tabulation in percentages of clean fruit at picking time.

Percentage of clean fruit July 9 and at harvest in spraying experiment under discussion:

Treatments:	July 9	At Harvest	Decrease in Clean Fruit
1.....	58.6	49.4	9.2
2.....	48.1	39.7	8.4
3.....	41.1	32.3	8.8
4.....	45.9	42.7	3.2

These figures indicate that all of these treatments held the increase of codling moth which we expect from first to second brood to a low rate. We should normally expect that with an infestation of the magnitude indicated by the counts of July 9 that practically all apples would have been infested by harvest time. Instead of all apples being infested, however, we see that while the percentage of clean fruit decreased (or wormy apples increased) on all plots in no case was the decrease of clean apples (or increase of wormy apples) as much as the 10 per cent ordinarily considered necessary for significance in field experimentation.

The differences in materials are not considered significant in this work.

ACID TOLERANCE OF THE Highbush BLUEBERRY

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SECTION OF HORTICULTURE

Coville's studies (1) with the highbush blueberry showed that one of its principal requirements for satisfactory growth and productivity is an acid soil. Quantitative data indicating at least approximately, the pH (or acidity) tolerance of the plant were first reported in 1934 by Johnston (2). The plants used in his experiments grew fairly well on a soil as acid as pH 3.4, and lead to the belief that few Michigan soils are so highly acid that they are unsuitable for blueberry culture. However, poor growth, or even failure of plants has been noted on certain extremely acid soils in southern Michigan.

Field Observations

In the spring of 1932 a 14-acre field of highbush blueberries was set at Grand Junction, Mich. The soil had been well prepared for the plants and pH tests (4.4) and water-table determinations (12" to 36") revealed conditions favorable to growth. Nevertheless, after two years' growth many plants were missing and by the spring of 1937 the plants in an irregular area of three or four acres were dead. At that time

a thorough investigation of the soil was made. The available nitrogen, phosphorus, potassium, and calcium content of the soil was determined by the Spurway (3) method. These analyses are presented in Table 1 and indicate favorable quantities of each nutrient for the growth of blueberries.

The pH (acidity) values of the soil were extremely low (pH 3.2) in the areas where the plants were dead or dying. However, inasmuch as Johnston had grown plants successfully in soil with a pH value of 3.4 (only slightly less acid) this was not considered to be the cause of the poor growth and dying out of the plants, though from the analyses (Table 1, sample 1 and sample 2) the only apparent significant differences were in pH values, potassium and calcium content. It was therefore decided to undertake some greenhouse cultural experiments accompanied by field trials using the highbush blueberry as the test plant and employing various soil amendments.

Table 1. Analysis of soil, tested by the Spurway method.
(Figures give parts per million)

	Sample 1* Tested in 1937	Sample 2** Tested in 1937	Sample 3† Tested in 1938
Reaction (pH)....	3.2	4.4	3.8
Nitrates....	5.0	5.0	20.0
Phosphorus....	1.0	1.0	.5
Potassium....	5.0	10.0	10.0
Calcium....	20.0	75.0	40.0
Ammonia....	2.0	2.0	....
Iron....	Trace	Trace	....
Magnesium....	....	Trace	5.0
Manganese....	High	High	High
Organic Matter....	High	High	High

*Sample 1—soil was taken from area near plant shown in figure 2A.

**Sample 2—soil was taken from area in field where plants were making normal growth.

†Sample 3—soil was taken from area near plant shown in figure 2B. Sample was taken and analyzed a year after treatment was applied.

Greenhouse Experiment

A quantity of soil, representative of the area where the plants were missing, was taken from the field, screened and thoroughly mixed. Three and one-half gallon galvanized steel pails were coated on the inside with an asphalt paint and then filled with 27 pounds of the soil. A single one-year-old, well-rooted cutting of the Rubel variety was set in each pail. Sufficient pails were filled to allow three replications for each treatment listed in Table 2. The pails were then taken into the greenhouse where they remained from April 1 until the middle of October 1937. They were then removed to an outside shed where they remained during the winter. On March 1, 1938, they were again taken into the greenhouse to remain throughout the growing season. The temperature in the greenhouse was held uniformly at a mean of 70° F. until the early part of the summer and thereafter allowed to vary with the outdoor temperature. The amount of water that this soil would hold was determined by the Hilgard cup method and then reduced 10 per cent. The moisture content of the soil in the pots was held as uniformly as possible at that percentage, which was approximately 80 per cent of the field capacity, by bringing the pots to weight daily with distilled water.

Table 2. Schedule of fertilizer treatments for 1937 with amounts of material applied.*

1. Complete fertilizer, minus magnesium-manganese-lime
2. Complete fertilizer
3. Complete fertilizer, minus nitrogen
4. Complete fertilizer, minus phosphorus
5. Complete fertilizer, minus potassium
6. Complete fertilizer, minus magnesium
7. Complete fertilizer, minus manganese
8. Complete fertilizer, minus lime
9. Complete fertilizer, minus magnesium and manganese

*Sulphate of ammonia	125 pounds per acre or	.9789 grams per pot
Superphosphate	250 pounds per acre or	1.9578 grams per pot
Sulphate of potash	125 pounds per acre or	.9789 grams per pot
Magnesium sulphate	50 pounds per acre or	.3915 grams per pot
Manganese sulphate	50 pounds per acre or	.3915 grams per pot
Limestone	4,000 pounds per acre or	31.3248 grams per pot

Limestone was applied at the rate of a ton per acre and thoroughly mixed with the soil before filling the pots. The following spring a second application of a ton per acre was made and worked into the first inch or so of the soil. The other fertilizers were applied after the buds started to break, being applied to the surface of the soil and carried down into it when watered.

The plants under treatment No. 1 in which magnesium, manganese and limestone were withheld and treatment No. 8, in which only limestone was withheld, started to grow normally and continued until about the first of July. At that time the tips of all the leaves on the terminal shoots began to show signs of burning. This burning was similar to that observed under field conditions, beginning at the tips of the terminal leaves and finally progressing across the entire leaf. This condition continued down the shoots into the older leaves until by the latter part of August the plants were practically defoliated.

All plants receiving limestone grew normally and showed no signs of either tip or marginal burning at any time during the growing season. The omission of magnesium or manganese alone, or of both, had no noticeable effect upon the growth of the plants; however, when limestone was omitted from the treatment injury resulted. Figures 1A and 1B show a plant from treatment 1 and a plant from treatment 9. These plants received the same applications of nitrogen, potash and phosphorus, but plant B received in addition ground limestone equivalent to two tons per acre in two applications, the first one at the time the soil was put into the pots and the second at the beginning of the second growing season. The soil reaction at the beginning of the experiment was pH 3.2; at the time the photograph was taken the pH of the soil in Fig. 1A had not changed while that in Fig. 1B had been increased to pH 3.9. The plant shown in Fig. 1B is typical of all plants to which limestone had been applied. Owing to the sufficient quantity of nitrogen, phosphorus and potash in this soil the omission of those elements from the treatments had no noticeable effect upon the growth of the plants.

Field Treatments

In the field the only treatment made was No. 9 (complete fertilizer, minus magnesium and manganese). Two plots, each receiving the same treatment,



Fig. 1A and B. Plant A check, received one application of nitrogen-phosphorus-potash, pH of soil 3.2. Plant B received same treatment as plant A plus two applications of ground limestone, equivalent to 2,000 pounds per application. The pH of this soil was 3.9 at the time the picture was taken.



Fig. 2A and B. Plant A growing under field conditions is six years old. Plant B is two years old and is growing in soil from same area as plant A, but has received two applications of ground limestone, each application equivalent to 2,000 pounds per acre.

but in different locations, and each containing 110 plants, or approximately one-tenth of an acre, were treated with a 5-10-5 fertilizer at the rate of 500 pounds per acre and an application of ground limestone at the rate of one ton per acre at the time the soil was fitted for planting. The following spring a second application of ground limestone, at the rate of one ton per acre was made.

Figures 2A and 2B show two plants growing under field conditions. Figure 2A, a plant typical of those growing in the area where the plants were weak and dying is shown as it appeared July 26, 1938, and was in its sixth season of growth. The pH of the soil near this plant was 3.2, the same as the soil that was taken into the green house and used in the pot cultures. Figure 2B shows a typical plant from the plots that had received two applications of ground limestone, each equivalent to a ton per acre. The pH of the soil near this plant had been increased from pH 3.2 to pH 3.8. These two plants were photographed the same day. Although the plant in Fig. 2B was in its second seasons' growth it was much larger than the older plant growing on the more acid soil.

According to Johnston's (2) work there is a range of pH through which blueberry plants will make a successful growth, and also a point at which both plant growth and production begin to decrease (Table 3) (2), with an optimum at a pH value of approximately 4.4. The value of pH 3.4 at which he found the plants to make a fair growth and to be fairly productive is evidently a limit beyond which it is unsafe to go unless liming is resorted to and even between acidities of pH 3.4 and 4.0 light applications of lime are desirable.

Table 3. Yield records when plants were grown in soil of varying pH values. (2)

Soil Reaction	Yield in Ounces*	
	Second Year	Third Year
pH 3.4	45 0	138.0
pH 4.4	100 0	301.0
pH 5.5	1/8	17.0
pH 6.8	1/8	.0

*In each case yield records were from twelve plants

Summary

1. There is a minimum pH limit for the blueberry plant at approximately pH 3.2.
2. Symptoms associated with too great acidity are leaf scorch beginning at the margins and, finally, death of the plants.
3. Of the several treatments, applications of lime sufficient to raise the pH to 3.4-3.8 prevented leaf scorch and resulted in normal growth.

Literature Cited

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2. Johnston, Stanley. The Cultivation of the Highbush Blueberry. Mich. Agr. Exp. Sta. Spec. Bul. 252. 1934.
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DAMAGE TO NORWAY SPRUCE PLANTATIONS BY THE WHITE PINE WEEVIL

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While it has been recognized that the white pine weevil (*Pissodes strobi* Peck) will attack Norway spruce [*Picea abies* (L.) Karst] (1, 2), the extent of the damage by this insect to plantations of Norway spruce in Michigan has received little attention.

The Dunbar Forest Experiment Station, near Sault Ste. Marie, Mich., has two small plantations of Norway spruce. These plantations, which have a total area of 20 acres, were established in 1928 and 1929 upon land formerly under cultivation. The soil is Bruce fine sandy loam, with slow surface drainage owing to the general lack of relief. The plantations have received no care other than routine protection since establishment.

These plantations were examined during the summer of 1938 to determine the nature and extent of the damage caused by the white pine weevil. It was found that the nature of the damage differed somewhat from the typical damage to white pine (*Pinus strobus* L.). It was noted that while in white pine the damage is usually confined to the leaders of the current and previous year, in the case of Norway spruce the damage was often more widespread. Injury sometimes extended to growth made three to five years previously. The reduction in height growth is also greater than in the case of white pine. Since the tendency towards axial growth is apparently not so pronounced in Norway spruce as in white pine, the damage to the main stem is much more difficult to overcome. The greater difficulty apparently encountered in replacing the affected leader results in more pronounced deformation than in the case of white pine.

Height measurements of healthy and infested trees revealed that the smallest trees were seldom infested, nevertheless, the average height of the infested trees was 3.1 feet as compared to 3.5 feet for the healthy trees.

The examination revealed that 14 per cent of the trees in the plantation had been weeviled at some time prior to the current season, and that 5 per cent of the trees had been weeviled during the current season. The total infestation, past and present, was therefore 19 per cent.

The plantations are adjoined on one side by a white pine plantation of the same age. This plantation has suffered annually from the white pine weevil but has received a considerable amount of control work. The local population of white pine weevil might therefore be somewhat less than would be expected had there been no control measures.

In summary, it may be stated that the white pine weevil seriously damages plantations of Norway spruce growing under the conditions described. Indications are that white pine weevil damage should be seriously considered before establishing pure plantations of Norway spruce in close proximity to stands of white pine subject to attack by the white pine weevil. While

this study was made in the eastern portion of the Upper Peninsula of Michigan the results may also have limited application elsewhere under comparable conditions.

Literature Cited

1. Graham, S. A. The Biology and Control of the White Pine Weevil, *Pissodes strobi* Peck. Cornell Univ. Agr. Exp. Sta. Bul. 449. 1926.
2. MacAloney, Harvey J. The White Pine Weevil (*Pissodes strobi* Peck)—Its Biology and Control. Bulletin of New York State College of Forestry, III: I. Tech. publication 28. 1930.

DAMAGE TO RED PINE NURSERY STOCK BY THE SMALL PINE SAWYER

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The small pine sawyer (*Monochamus scutellatus* Say.) is a common forest insect throughout the coniferous forests of the Northeastern and the North Central States. The habits and life history have been described by Graham (2), Tothill (3) and others.

This species is one of the secondary wood-boring insects and causes considerable damage to freshly cut logs and dead standing trees. Graham mentions, however, that during the flight period, adults of the small pine sawyer feed on the green bark of pine twigs. This damage was studied by Faull (1) who found that injury was due to the beetles chewing away the bark on the under side of twigs. Damaged twigs usually died by the following spring. Balsam fir was found to be most subject to attack; but injury to white pine, red pine, jack pine, white cedar, black spruce, and white spruce was also noted.

Another type of damage by this insect was noted in July and August 1938 at the Dunbar Forest Experiment Station near Sault Ste. Marie, Mich. The small pine sawyer was found to be damaging 4-year-old red pine transplants and 3-year-old seedlings in the forest tree nursery. Damage consisted of a chewing away of the bark and cambium tissues along one side of the leader. In some cases the leader was nearly severed. The trees did not die at once but were so badly damaged as to be unsuitable for planting. About 200 trees were thus damaged, the affected trees occurring in small groups.

Control was effected by hand picking of the beetles from the infested nursery beds. Since the nursery is small this control method was satisfactory. Since the insect breeds in areas of coniferous slash and dead timber, a control measure consists of cleaning up nearby areas of slash and down timber. However, in this case there were no cut-over areas nearby. The infestation must have originated from scattered balsam fir trees, a number of which were killed in the surrounding forest by the drouth of 1936.

Literature Cited

1. Faull, J. H. Report of the Minister of Lands and Forests for the Province of Ontario for 1923, "Red Branch" of balsam, fir, pine, and cedar due to injury by *Monochamus* spp. 1923.
2. Graham, S. A. "Principles of Forest Entomology." 1929.
3. Tothill, J. D. New Brunswick Land Department Annual Report 63: 86-87. 1923.

BULLETIN REVIEWS

Circ. Bul. 170.—Keys to the Species of Ribes Occurring in the Great Lakes Region.—Darlington, H. T. and Culver, L. B.—Brief descriptions together with winter and summer keys to the species of currants and gooseberries found in the Great Lakes region. (24 pp., 13 figs.)

Spec. Bul. 299.—Soil Management for Potatoes.—Grantham, G. M., Millar, C. E., Mick, A. H.—In 1935 potatoes were grown on 81 per cent of all farms in Michigan for either commercial or home use. The major acreage is to be found on the sandy loams. These soils naturally have low water-holding capacity and with their low content of organic matter, moisture deficiency at drouth periods becomes a controlling factor in potato production. Potatoes remove from the soil comparatively large amounts of nutrients. Manures, supplemented by commercial fertilizers, will help maintain the organic matter content and supply those elements necessary for good potato production. Because of the possibility of scab infection, fresh manure should not be used. Applications of farm manure should be moderate rather than heavy. Many trials of different analyses and rates of fertilizer used in the potato-producing sections have shown the 3-12-12 or 4-16-8 grades applied at the rate of about 500 to 600 pounds per acre consistently give the highest yields.

Fertilizer placement trials have shown that applications in bands 2 inches out from, and on the level with, the seed piece have given slightly better yields than the same fertilizers placed in other locations. Placement of fertilizers below the seed piece should be avoided because of excessive draft on the planter. Placements where fertilizers were mixed with the soil around the seed caused a delay in sprout emergence.

Under irrigation, it was found that larger amounts of fertilizers could be economically used and fertilizers could be placed nearer the seed pieces without harmful results.

Fertilizer applications made with the cultivator attachment at the time of first cultivation proved advisable when fertilizers had not been previously applied. (31 pp., 26 tables, 2 figs.)

JOURNAL ARTICLE ABSTRACTS

Greenhouse Studies of the Effect of Clipping the Tops of Alfalfa at Various Heights on the Production of Roots, Reserve Carbohydrates and Top Growth.—Harrison, C. M.—*Plant Physiology*. 14: 505-516. 1939. [Journal Article No. 320 (n. s.) from the Michigan Agricultural Experiment Station.]—Alfalfa plants were grown in sand culture under greenhouse conditions and clipped at 1 inch, 2 inches gradually and at 6 inches for eight consecutive weeks. Subsequent growth of tops was materially lessened in cultures which were cut to 1 inch in comparison to those cut gradually to 2 inches and those cut at 6 inches. The plants cut to 1 inch weekly had roots at the close of the experiment which contained only 50 per cent as much dry matter as comparable roots harvested before cutting was begun; the roots, from those cut to 2 inches gradually, were approximately equal to the "initial" checks while those cut at 6 inches produced dry matter in the roots 3 times as great as the roots of the "initial" checks.

Photographs and photomicrographs of roots are shown indicating the amount of starch present in plants harvested before cutting was begun and from the various cutting treatments at the close of the experiment.

The Influence of Climatological Factors on Anthesis and Anther Dehiscence in the Cultivated Cucurbits. A Preliminary Report.—Seaton, H. L. and Kremer, J. C.—*Amer. Soc. Hort. Sci.* 36: 627-631. 1938. [Journal Article No. 342 (n. s.) from the Michigan Agricultural Experiment Station.]—Field observations of the anthers of at least 10 flowers of each of the representative varieties of the cultivated cucurbits were made hourly with a binocular microscope. Temperatures and humidities were recorded by a hydro-thermograph located in the field and the conditions of sunlight, wind movements, stage of anthesis, and bee activity were evaluated at hourly intervals.

In the 1937 observations on pickling cucumbers the time of day and temperature influenced the time of anthesis and anther dehiscence more than any of the other climatological factors studied. Anthesis and dehiscence usually occurred between 6 a. m. and 9 a. m. The mean of 140 observations was 8 a. m. The time of day and the stage of anther dehiscence were correlated on the 140 observations and a highly significant coefficient of correlation ($\sqrt{}$) of $.2724 \pm .0528$ was obtained. Though the time of day was apparently a controlling factor of anthesis and anther dehiscence, it undoubtedly was modified by temperature. When 126 observations of temperature and stage of anther dehiscence

were correlated, a highly significant value for $\sqrt{}$ of $.6017 \pm .0383$ was obtained. The mean of all observations was approximately 65° F. Humidity, cloudiness, and wind movements apparently were not operative in influencing the time of anthesis or dehiscence. Bee activity in the cucumber flowers was found to be closely related to the stage of the blossoms.

In all of the species and varieties included in the 1938 studies, temperature and time of day were found to be most operative in influencing anthesis and anther dehiscence. The latter in each case was influenced directly by the former. Based on the optimum temperatures for anthesis and dehiscence the species may be separated in three groups as follows: (a) The pumpkins and squashes, where the minimum temperature for anthesis and anther dehiscence was between 48° and 50° F. with the optimum between 50° and 55° F. (b) The watermelons, gherkins and cucumbers, where anthesis begins to occur between 58° and 60° F. and dehiscence between 62° and 63° F.; optimum temperatures for both anthesis and dehiscence for this group were between 65° and 70° F. (c) The cantaloupes, casabas, and honey dews, where the minimum temperature for anthesis and dehiscence was 65° F. with optimum between 70° and 75° F.

The Role of Spices in Pickled-food Spoilage.—Fabian, F. W., Krehl, C. F. and Little, N. W.—Food Research. 4: 269-286. 1939. [Journal Article No. 335 (n. s.) from the Michigan Agricultural Experiment Station.]—Samples of whole and ground spices purchased on the open market had a bacterial plate count ranging from 0 to 67,000,000 per gram. Samples of the oils of spices, 50-per cent emulsions of spices, and spices in a sugar-soluble base were found to be sterile. Ground cinnamon and cloves were the only spices that exhibited any inhibiting action on bacterial growth in low concentrations. Ground peppercorn and allspice showed inhibiting action in 1-per cent concentrations; mustard, mace, nutmeg, and ginger in 5-per cent concentrations; and celery used in 10- and 20-per cent concentrations in nutrient agar against a majority of the bacteria tested. Some bacteria grew on all concentrations of some of the spices. There is a great difference in the resistance of different bacteria to the same spice and the same organism to different spices.

Staphylococcus aureus was more susceptible to the action of spices than many of the other bacteria tested.

The oils of spices, 50-per cent emulsions of the oils and soluble-sugar bases of the oils, were more inhibitory than the ground spices.

Unsterilized spices, when added to processed dill pickles, spiced peaches, and pears, caused a weakening in the cellular structure which led to slippery and soft pickles and to soft and mushy fruit.

The Determination of Blood Plasma Carotene in the Bovine Using a Photoelectric Colorimeter.—Moore, L. A.—Jour. Dairy Sci. 22 (7):

501-511. 1939. [Journal Article No. 344 (n. s.) from the Michigan Agricultural Experiment Station.]—A simple phase separation of carotene from bovine plasma has been outlined. When petroleum ether is used as the solvent, the boiling point and temperature of extraction are important factors in the amount of carotene extracted. When petroleum ether with a boiling point of 73-76° C. was used and the extraction carried out at 10-12° C. the epiphase gave true carotene values. When the phase separation method is used, the relationship of the amount of carotene in the epiphase to the total amount present in the sample should be established. The temperature at time of pipetting into the absorption cell under ordinary laboratory conditions had no measurable effect on the galvanometer readings. The use of 15 ml. of a 95 per cent ethyl alcohol for precipitation of the proteins from 10 ml. of plasma was found to be advantageous. Shaking the tubes for two- to three-minute periods gave more consistent results than shaking for one minute. The addition of 0.5 ml. of alcohol to destroy emulsions had no effect on the determination. The method was shown to give consistent results from day to day. Plasma stored at 2.0° C. showed no loss of carotene over a period of three weeks. The use of the phase separation method in conjunction with the photoelectric colorimeter offers a simple and rapid procedure for the determination of carotene in bovine blood plasma.

Effect of Pasture Upon the Carotene Content of Blood Plasma of the Bovine.—Moore, L. A.—*Jour. Dairy Sci.* 22 (7): 513-519. 1939. [Journal Article No. 345 (n. s.) from the Michigan Agricultural Experiment Station.]—Different breeds kept under similar conditions of feeding ranked in increasing order of plasma carotene values as follows: Brown Swiss, Holstein, Ayrshire, Jersey and Guernsey. There was little difference between the first three. Within the breed there was little difference in the level of plasma carotene values among cows producing milk under winter conditions.

Heifers within the breed had definitely lower plasma carotene values than producing cows under both winter and pasture conditions.

Cows producing the larger amount of milk within the breed in general showed a greater increase in the level of plasma carotene when they were turned to pasture. One cow with a very low initial plasma carotene value showed an increase within 15 hours after being fed freshly cut alfalfa.

The Nomenclature of Categories Lower Than Species.—Sabrosky, C. W.—*Ent. News.* 50:197-203. 1939 [Journal Article No. 356 (n. s.) from the Michigan Agricultural Experiment Station.]—Basic principles and problems relating to the naming of subspecies, varieties and similar taxonomic units are critically reviewed. From the prevailing inconsistencies in interpretation and usage, certain conclusions are drawn on the needs of modern systematic zoology.

The Effect of Height and Frequency of Cutting Alfalfa Upon Consequent Top Growth and Root Development.—Hildebrand, S. C. and Harrison, C. M.—*Jour. Am. Soc. Agron.* 31 (9): 790-799. 1939. [Journal Article No. 368 (n. s.) from the Michigan Agricultural Experiment Station.]—Triplicate sand cultures of alfalfa plants were subjected to weekly, bi-weekly and monthly cutting intervals at 1, 3, 6, 9, and 12

inches, respectively. Yield of tops is recorded in grams dry matter. Cutting treatments continued for a 12-week period after which all the cultures were completely defoliated and followed by 4 more successive weekly defoliations. Cultures cut frequently and close to the crown showed a marked decrease in yield of tops and storage materials in the roots, as evidenced by lack of growth between the intervals of complete defoliation, when compared to those cultures cut less frequently or at higher cutting level. At the 12-inch level of cutting, yield of tops decreased but storage materials increased. Photographs showing the condition of the plants at the beginning and close of the experiment are included.

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Four series of publications are issued by the Michigan Agricultural Experiment Station—Circular, Special, Technical, Quarterly—and the Extension Division issues an Extension series, and also a series designed especially for Boys' and Girls' 4-H Club members. The **Extension** (E) bulletins and the **Circular** (C) bulletins are popularly written articles of information on the subjects indicated. Their subject matter is based on the results of investigations at the Experiment Station and on other sources of information. The **Special** (S) bulletins report on specific investigations conducted by the Michigan Station. They are written in popular style so as to be of use to farmers and others interested in the subjects in question. The **Technical** (T) bulletins likewise report on specific investigations of the Michigan Station but deal with subjects that from their very nature must be described in more or less technical language. They are printed in small editions and are intended especially for libraries, investigators, teachers, extension men, county agricultural agents and other specialists who may have use for them. The **Quarterly** bulletins contain timely articles of information for farmers, based largely on the work of the Agricultural Experiment Station.

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- S172 Farm Real Estate Assessment Practices in Michigan
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- S189 The Marketing of Michigan Milk

- S199 Studies in Swine Feeding
- *S206 Types of Farming in Michigan
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- S270 The Economics of Bean Production in Michigan
- S278 The Production-Consumption Balance of Agricultural Products in Michigan: Part III Field Crops
- S284 Economic Aspects of Lamb Feeding in Michigan
- S286 Cost of Apple Production in Berrien County, Michigan, in 1936
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- S294 Profitable Poultry Management
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- E110 Bang's Disease
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- E201 Sleeping Sickness (of Horses)

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- C95 Feeding Minerals to Dairy Cattle
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- E140 Milk—The Ideal Food
- E165 Mastitis

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- C101 Cockroaches, Silverfish and Book-lice
- C104 Clothes-Moths and Carpet Beetles
- C107 The Mexican Bean Beetle

- C132 June Beetles or White Grubs in Michigan
- C133 Soft Scales Injurious to Deciduous Ornamentals
- C134 Wood Boring Insects which Attack Furniture and Buildings
- C141 Some Chewing Insects Infesting Michigan Evergreens
- C144 Flies and Mosquitoes Commonly Found About Michigan Homes
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- S239 The Principal Grape Insects in Michigan
- S243 Important Leaf Feeding and Gall Making Insects Infesting Michigan's Deciduous Trees and Shrubs
- S244 Insect Pests of Stone Fruits in Michigan
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- S277 Insecticide Experiments on Codling Moth in Michigan, 1929-1935
- E59 Corn Borer Control by Good Farming
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- E75 The Oriental Peach Worm
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- E121 Codling Moth Situation in Lower Michigan
- E125 Insects Infesting Golf Courses and Lawns
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- E144 Fleas, Bedbugs, and Human Lice
- EE154 Supplement to Spraying Calendar No. E154, which is temporarily out of print
- E161 Sucking Insects Infesting Apples and Pears in Michigan
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- E166 Ant Control in Houses and on Lawns
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- E180 Controlling Chewing Insects on Garden Crops
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- E193 Michigan Termites
- E194 Controlling Shield Scales of Deciduous Trees
- E198 Controlling Plant Lice on Field and Garden Crops

FARM MANAGEMENT

(See Agricultural Economics)

FERTILIZERS (See Soils)**FLORICULTURE**

(See Landscaping and Plantings)

FOODS (See Home Economics)**FORESTRY**

- S190 Oak Forests of Northern Michigan
- S196 The Farm Woodlot in Michigan
- E147 Forest Planting on Michigan Farms
(Also see 4-H Club Bulletins)

FRUITS (See Horticulture)**4-H CLUB**

The 4-H Club Bulletins are special subject bulletins prepared for leaders and members of Michigan 4-H Clubs. Copies of these bulletins for the use of the 4-H Clubs may be secured from the office of your County Agricultural Agent.

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- H2 Potato Club Work
- H3 Michigan 4-H Bean Clubs
- H7 Corn Club Work
- H9a The Well-Dressed Girl in Cotton, Project I
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- H9c The Summer Costume
- *H9d The 4-H Girl in Wool
- H10 Canning
- H11a Handicraft Club Work (Wood Work)
- H11b Handicraft Club Work, Advanced
- *H11c Handicraft Club Work, Advanced
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- H28 Health
- H29 Conservation Program for Michigan 4-H Clubs
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- H30a 4-H Food Preparation, Project II—Luncheon and Supper
- H31 Forest Fire Study for 4-H Clubs (First year)
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- H32 4-H Food Preparation, Meal Planning, Project III—Dinner
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- H35 Advanced 4-H Canning
- H36 4-H Pheasant Propagation Management Project
- H37 Electrical Projects for 4-H Clubs
- H38 4-H Sheep Club Manual
- H39 4-H Colt Club Manual
- *H40 Michigan Deer Herd
- *H41 Soil Conservation for 4-H Clubs

HOME ECONOMICS

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- C98 How to Make, Clarify and Preserve Cider

- C151 Methods and Problems of Farm Butter Making
- C164 Fruits for Year Around Use
- C167 Controlling Rats and House Mice
- E120 Making Rugs
- E132 Home Canning
- E136 Living With Pictures
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- E142 Household Closets and Storage Spaces
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- E145 Homemade Pickles and Relishes
- E149 Honey Vinegar
- E150 Hints for Using Honey
- E151 The Home Meat Supply
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- E168 Reseating Chairs
- E169 Color in Home Decoration (One Copy free to Michigan residents; 10 cents per copy to non-residents.)
- E170 Color for Clothes
- E182 Attractive Kitchens
- E184 Modern Laundry
- *E185 Convenient Kitchens
- *S204 Canning Meat
(For Control of Household Insects,
see Entomology)

HORTICULTURE

(Apples, Berries, Grapes, Melons, Vegetables, Bees)

- C98 How to Make, Clarify and Preserve Cider
- C124 The Young Vineyard
- C130 Cultural Method of the Bearing Vineyard
- *C143 Construction and Management of Air-cooled and Cold Storages with Special Reference to Apples
- C146 Three Virus Diseases of the Peach in Michigan
- C152 Raspberry Growing in Michigan
- C155 Selection of Orchard Sites in Southern Michigan
- C160 Protecting Cherries from Birds
- C162 Control of Soil Erosion in Michigan Orchards
- C163 Annual Cover Crops for Michigan Orchards
- C166 Water Conditioning for Greenhouses
- S126 An Analysis of the Peach Variety Question in Michigan
- S141 Profitable Pruning of the Concord Grape
- S142 Grafting in the Apple Orchard
- S164 Diagnosing Orchard Ills
- S178 Michigan Raspberry Diseases
- S182 Strawberry Growing in Michigan
- S184 Size of Peaches and Size of Crop
- S185 Roadside Marketing in Michigan
- S194 The Use of Peat in the Greenhouse
- S195 Maintaining the Productivity of Cherry Trees
- S203 Spraying Materials and the Control of Apple Scab
- S209 Consumers' Demand for Apples
- S218 Spray Injury Studies No. 1
- S219 Spray Injury Studies No. 2
- S220 Comparisons of Methods of Making Spray Applications

- S232 The Michigan Pear Industry, Its Status and Trends
- S237 Trends in Cherry Production
- S242 Grape Production Costs and Returns in Southwestern Michigan
- S252 The Cultivation of the Highbush Blueberry
- S257 Utilization of Land Types for Fruit Production, Berrien County, Michigan
- S258 Production and Price Trends in the Pitted Red Cherry Industry
- S265 The "Thin Wood" Method of Pruning Bearing Apple Trees
- S275 Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan
- S281 Graduated Space Method of Thinning Apples
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- E196 Protecting Fruit Trees Against Mice and Rabbits

(Vegetables)

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- C140 Home Production of the Family's Food Supply
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- C169 Marketing Michigan Vegetable Crops
- S249 Cabbage Varieties
- S259 The Influence of the Length of the Interval Between Pickings on the Yield and Grade of Pickling Cucumbers
- S260 Yellow Dwarf Disease of Potatoes
- S267 An Economic Study of the Potato Enterprise in Michigan
- S271 The Katahdin Potato in Michigan
- S273 The Production of Cucumbers for Pickling Purposes
- S288 Marketing Potatoes in Michigan
- S290 Tomato Varieties
- E83 Growing Peas for the Canning Factory
- E130 Small Sash House for Growing Vegetable Plants
- E156 Tomato Growing in Michigan
- E158 Timely Tomato Topics
- E162 Michigan Potato Diseases and Their Control
- *E200 Controlling Vegetable Diseases in Seed-bed and Coldframe

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- C133 Soft Scales Injurious to Deciduous Ornamentals
- C149 Gladiolus Culture, Insects, and Diseases
- C156 Management of Bent Grass Lawns
- S222 Garden Roses
- S228 The Rock Garden
- SS228 Supplement—Lists of Rock Garden Plants
- S266 Dahlias, Their History, Classification, Culture, Insects and Diseases
- S282 Wax Emulsions for Spraying Nursery Stock and Other Plant Materials

- E125 Insects Infesting Golf Courses and Lawns
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- E166 Ant Control in Houses and on Lawns
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- E178 Evergreens
- E199 Landscaping the Home Grounds

(For additional references on Insects affecting Ornamentals, see Entomology)

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- C135 Chestnut Blight in Michigan
- C139 Tomato Diseases in Michigan
- C142 Common Diseases of Cereals in Michigan
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- E176 Oat Smut Control
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- E190 Dust Treatment for Seed Corn Diseases
- E200 Controlling Vegetable Diseases in Seed-bed and Coldframe

POULTRY

- E51 Feeding for Egg Production
- E52 Care and Feeding of Growing Chicks
- E124 Portable Range Shelter
- E137 Michigan Turkeys
- S294 Profitable Poultry Management

SOCIOLOGY

- S207 Public Health and Educational Services in Michigan
- S208 Service Institutions and Organizations in Town-Country Communities
- S226 Activities of Churches in Town-Country Communities
- S229 Rural School Organization in Michigan
- S236 Population Trends in Michigan
- S261 Changes in the Retail and Service Facilities of Rural Trade Centers in Michigan, 1900 to 1930
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SOILS (Fertilizers, Lawns, Erosion)

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 E38 Fertilizing the Mature Apple Orchard
 E57 Lime for Michigan Soils
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VEGETABLES (See Horticulture)

VETERINARY SCIENCE (See Animal Pathology)

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MISCELLANEOUS

- C158 Commercial Mushroom Production
 C167 Controlling Rats and House Mice
 S247 Recreational Use of Northern Michigan Cut-over Lands
 S279 Identification of Sex of Beavers
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 T48 Lecania of Michigan
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 T82 Commercial Casein
 T84 The Clarifier and the Filterer in Processing Milk
 T85 Studies in the Etiology of Roup and Allied Diseases of Fowls
 T86 The Relation of Milk Solids Not Fat to Overrun and Quality of Ice Cream
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 T97 Studies on the Overwintering and Modes of Infection of the Fire Blight Organism
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 T121 Fermentation Studies with Soft Wheat Flours
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- T133 Insurance of Farm Families
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 T148 On the Control of Tapeworm Infestation in Chickens with Notes on the Pathology of the Intestines of the Hosts
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 T152 A Study of Stewart's Disease of Sweet Corn Caused by *Phytomonas stewarti*
 T153 The Vaccinal Immunization of Cattle for Bang's Disease
 T154 The Toxicity of Combinations of Nicotine Under Michigan Conditions to the Tree and to the Codling Moth
 T155 The Fusarium Yellows Disease of Celery
 T156 Chemical Constitution and Biological Properties of the Endo-Antigen of the Brucella Group of Micro-organisms
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 T158 Factors Involved in Accuracy of Testing Milk Samples
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 T160 Physiological Investigations of Red Raspberry Plants Inoculated with Red Raspberry Mosaic
 T161 Studies in the Nature of the Pomological Variety
 T162 The Relative Importance of Various Factors Influencing Profits in Strawberry Production
 T163 Causes and Effects of Size Differences in Apple Trees in the Nursery
 T164 Effect of Heat on Milk With Especial Reference to the Cooked Flavor
 T165 Formulas For Finding Estimates For Two and Three Missing Plots in Randomized Block Layouts
 T166 Studies of The Eastern Ruffed Grouse in Michigan
 *T167 The Use of Fertilizers and Lime on Native Pastures in Michigan

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QUARTERLY BULLETINS

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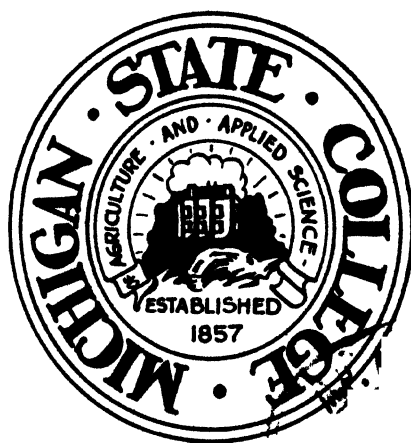
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**EDITED BY
V. R. GARDNER AND A. A. APPLIGATE**

**CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION**

MEASURING HYBRID CORNS FOR MICHIGAN 1938-1939 TRIALS

H. C. RATHER AND A. R. MARSTON
SECTION OF FARM CROPS

The fact that it is possible to develop lines of hybrid corn which are markedly superior to the best of the open-pollinated varieties of the past has become widely appreciated. Such superiority has most often been evinced in strong leafy stalk, well-developed, healthy root systems and, of course, higher productivity.

The individual corn grower, however, is not concerned with these characteristics as they apply to hybrid corn as a whole. His investment rests on the performance of individual corn hybrids. His task is to choose some particular corn hybrid which can be expected to produce to advantage on his farm.

The biggest variation among corn hybrids now available commercially has to do with maturity. To be sure, there is wide variation among hybrids as regards strength of stalk, root development, grain texture, color, even palatability, and each of these considerations is important. But the two most important questions the corn grower must have answered are (1) "Will it get ripe on my farm?" and, (2) "Is it superior in yield?"

Adaptation of Hybrids Tested

To test the adaptation of promising hybrids developed at the Michigan Agricultural Experiment Station and to aid in evaluating hybrids developed elsewhere (many of which are offered for sale in Michigan), the Farm Crops Section for the last five years has conducted a series of over-state trials of a large number of corn hybrids. Cooperation in this work has been extended by county agricultural agents, farmers, the Michigan Crop Improvement Association, corn breeders of other states, and seedsmen. These trials have been located in southeastern Michigan (Monroe County), southwestern Michigan (St. Joseph County), central Michigan (Ingham and Saginaw counties), the Thumb district (Huron County), and northern Michigan (Wexford and Otsego counties).

A summary of the results for the years 1935 to 1938 was published in the Quarterly Bulletin of the Michigan Agricultural Experiment Station a year ago.* The report presented herewith deals largely with results of the 1938 and 1939 trials which were considerably larger than those previously conducted and in which a large number of hybrids

*Measuring Hybrid Corns for Michigan—1935-1938 Trials. Mich. Exp. Sta. Quart. Bul., Vol. 21, No. 3, February 1939.

Maturity Classification of Corn Hybrids Based on 1938 and 1939 Michigan Trials

GROUP A

Will usually ripen in Zones 5 and 6 and other good Northern corn growing locations.

MINNESOTA 402 WISCONSIN No. 25

KINGSCROST E (o.p.)*

NORTHWESTERN DENT

(o.p.)*

GROUP B

Should generally mature throughout Zone 4 and much of Zone 5.

WISCONSIN 325 WISCONSIN 340

WISCONSIN 355 WISCONSIN 350

KINGSCROST D WISCONSIN 404

GROUP C

Zone 3 and conditions in Zones 1 and 2 demanding early corn.

MICHIGAN 1218 M. A. C. YELLOW DENT

GOLDEN GLOW (o.p.)*

(o.p.)*

PICKETT (o.p.)*

GROUP D

Favorable locations in Zone 3 and conditions in Zones 1 and 2 demanding moderately early corn.

WISCONSIN 531

PIONEER 355

WISCONSIN 525

GROUP E

Widely adapted in Zones 1 and 2.

KINGSCROST FK DUNCAN (o.p.)*

WISCONSIN 645 WISCONSIN 570

WISCONSIN 625 WISCONSIN 606

IOWA 931 DE KALB 202

OHIO K-23 IOWEALTH 95

GROUP F

Favorable locations in Zones 1 and 2.

PIONEER 322 IOWEALTH 100

KINGSCROST FB FUNK G 27

WISCONSIN 676 FUNK G-8

WISCONSIN 680

GROUP G

Probably hazardous unless planted by May 12 in Zones 1 or 2 with very favorable growing conditions throughout the season.

IOWEALTH 105 PIONEER 349

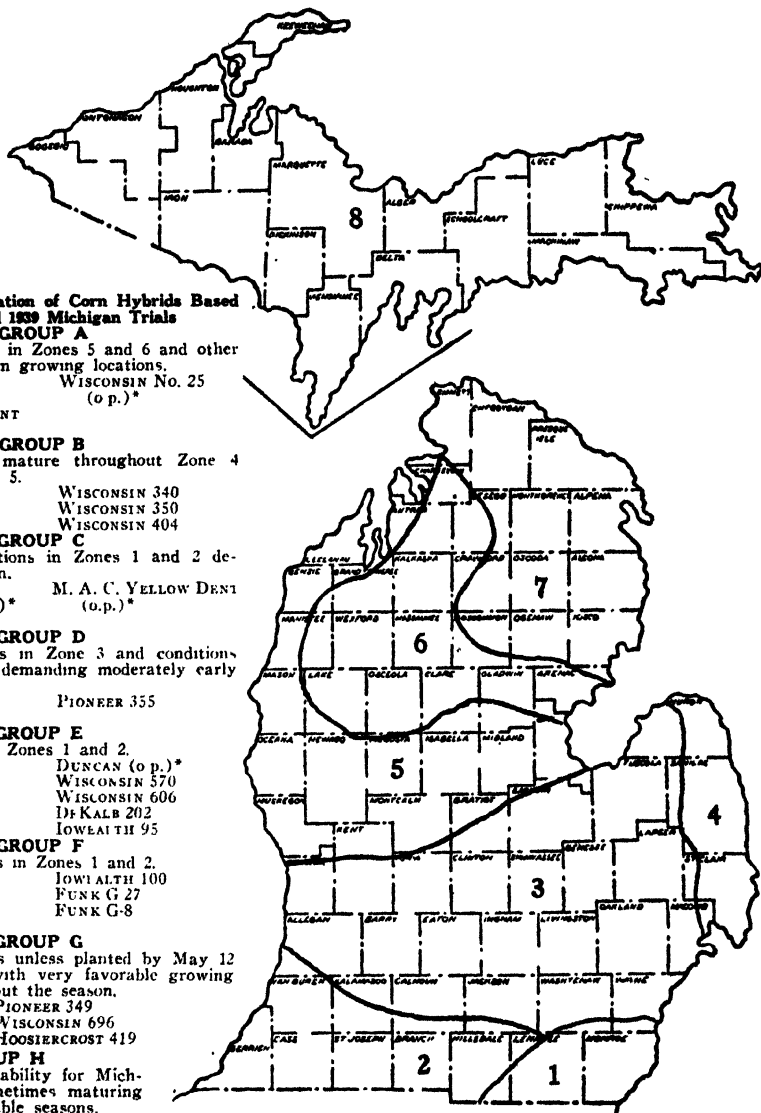
PFISTER 368 WISCONSIN 696

PFISTER 366 HOOSIERCROST 419

GROUP H

Of doubtful dependability for Michigan, although sometimes maturing in unusually favorable seasons.

PFISTER 266 INDIANA 416



were included in both seasons, thereby adding to the reliability of the results secured.

In each trial the corn strains tested were planted in 3-row plats 10 hills long. There were five such plats of each strain in each trial, the plat arrangement being altered at random for each series in order to reduce to a minimum the influence of soil variations on the comparative performance of the various strains. Soils do vary, however, (seasons likewise are variable) and hybrids themselves are by no means

100 per cent uniform in their performance. Therefore, a series of tests over a period of years is required as a basis for establishing the merit of any particular line with reasonable assurance.

The seasons of both 1938 and 1939 were unusually favorable for ripening corn. Many hybrids included in the Michigan trials matured fully in these two seasons at locations where such lines would produce only soft corn in less favorable seasons. To avoid drawing misleading conclusions from the performance of such hybrids a special maturity study of all hybrids included in the over-state trials was made in 1939. Moisture determinations as indicators of relative maturity were made not merely at harvest time but at three different dates (four at East Lansing) preceding harvest. With this increased information as a basis the hybrids reported on herewith have been arranged in groups of similar maturity. Information gained in future trials may result in slight modification of these groupings but, for the most part, the authors believe that the maturity classification presented herewith offers a reliable guide to the comparative adaptation of the hybrids which have been tested.

Comparative yields fluctuate from year to year and test to test more widely than comparative maturity. We hope that most of the hybrids tested in 1938 and 1939 will be included in the trials of 1940 and subsequent seasons, thereby increasing the reliability of the yield and adaptation information which can be made available to Michigan corn growers.

Table 1. Average yield of varieties tested in Monroe County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Michigan Hybrid 1218.....	61.7	57.1	59.4
Pickett Yellow Dent (O. P.)*.....	55.6	53.8	54.7
Kingscrot Hybrid F. K.	67.6	74.7	71.1
Ohio Hybrid K-23.....	67.9	72.9	70.4
Wisconsin Hybrid 625.....	65.9	76.9	70.3
Iowa Hybrid 931.....	75.4	59.3	67.4
Wisconsin Hybrid 606.....	62.5	68.8	65.6
DeKalb Hybrid 202.....	66.9	63.7	65.3
Duncan Yellow Dent (O. P.)*....	60.1	62.9	61.5
Wisconsin Hybrid 570.....	47.1	72.5	59.8
Pioneer Hybrid 322.....	92.8	77.3	85.1
Funk Hybrid G-8.....	82.4	85.4	83.9
Wisconsin Hybrid 676.....	73.3	76.4	74.9
Iowa Hybrid 100.....	68.5	79.1	72.8
Kingscrot Hybrid F. B.....	60.6	80.1	70.4
Pfister Hybrid 366.....	90.7	76.0	83.4
Pioneer Hybrid 349.....	87.1	74.4	80.8
Pfister Hybrid 368.....	77.8	77.1	77.5
Wisconsin Hybrid 696.....	75.7	77.5	76.6
Funk Hybrid G-27.....	68.8	81.6	75.2
Michigan Hybrid 561.....	61.7	65.0	63.4
Indiana Hybrid 416.....	86.1	81.2	83.7
Pfister Hybrid 266.....	82.4	77.7	80.0

*Open-pollinated varieties.

Monroe Trials

The tests in Monroe County were conducted on the Monroe County Farm. From the standpoint of both soil and climate this is representative of Michigan's best corn growing conditions. The grain yield of all corns which were in the Monroe trials in both 1938 and 1939 are reported in Table 1. Michigan 1218 and Pickett corn, a standard open-pollinated variety, are earlier than is necessary for this location. They do not use all of the available growing season and consequently have been relatively low in yield in southern Michigan trials.

The corns which make up the second group in this table should prove widely dependable from the ripening standpoint under conditions comparable to those of the Monroe trials since Duncan corn, which is in this maturity class, has a long record of dependability in southern Michigan. In fact, many farms throughout this area can grow corn a little later than the Duncan variety in most seasons. Very productive hybrids answering this description are found in the third group.

From the comparative yields obtained there seems to be no advantage in planting in Michigan anything later than the hybrids in this third group. There is the definite disadvantage of experiencing greater



Fig. 1. Wisconsin Hybrid No. 645.

hazards as regards getting the crop ripe should the season prove unfavorable.

St. Joseph Trials

The St. Joseph County trials in 1938 and 1939 were planted on the farm of Robert Robinson near Mendon under excellent soil and cultural conditions. In 1939 more than 40 hybrids were in the maturity trials at East Lansing and in St. Joseph and Monroe counties. As an average, it required exactly the same number of days from date of planting until the grain was down to 40% moisture in the fall in St. Joseph County as in Monroe County and in both cases this was nine days less than the average requirement for the same hybrids planted on essentially the same date at East Lansing.

The general conclusions to be drawn from the St. Joseph County trials are therefore similar to those previously stated for Monroe. Michigan 1218 and Pickett proved too early, the hybrids listed in the second and third groups of this trial should prove generally satisfactory under conditions comparable to those in the trials, and later corns again showed no advantage in yield and their planting presents more hazards to the grower.

Table 2. Average yield of varieties tested in St. Joseph County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Pickett Yellow Dent (O. P.)*	54.2	89.0	71.6
Michigan Hybrid 1218	52.2	82.0	67.1
DeKalb Hybrid 493	68.6	105.9	87.2
DeKalb Hybrid 202	72.4	101.3	86.9
Iowa Hybrid 931	70.5	101.5	86.0
Ohio Hybrid K-23	62.9	106.5	84.7
Wisconsin Hybrid 645	68.5	98.4	82.5
Kingscrot Hybrid F. K.	61.9	96.9	79.4
Wisconsin Hybrid 606	52.6	94.4	73.5
Duncan Yellow Dent (O. P.)*	50.5	95.2	72.9
Pioneer Hybrid 322	75.7	115.9	95.8
Wisconsin Hybrid 680	68.6	107.6	88.1
Wisconsin Hybrid 676	73.3	100.3	86.8
Funk Hybrid G-8	58.9	113.4	86.2
Kingscrot Hybrid F. B.	62.9	104.6	83.9
National Hybrid 112	63.1	104.3	83.7
Pioneer Hybrid 349	72.8	109.7	91.3
Iowa Hybrid 105	73.1	109.2	91.2
Wisconsin Hybrid 686	70.9	105.3	88.1
Hoosiercrot Hybrid 419	71.4	104.1	87.8
Funk Hybrid G-27	64.0	105.7	84.9
Michigan Hybrid 661	64.7	95.0	80.2
Indiana Hybrid 416	92.9	111.6	102.3

*Open-pollinated varieties.

Ingham Trials

The trials in Ingham County were conducted on the Michigan State College farm at East Lansing. In the Ingham trials Kingscrot D appeared to be a little earlier than Michigan 1218 but in the Saginaw

Table 3. Average yields of varieties tested in Ingham County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Kingscrot Hybrid D.....	57.2	68.6	62.9
Michigan Hybrid 1218.....	51.4	73.5	62.5
Pickett Yellow Dent (O. P.)*.....	45.2	63.5	54.4
M. A. C. Yellow Dent (O. P.)*.....	44.0	67.5	55.8
Wisconsin Hybrid 531.....	53.3	75.4	64.4
Pioneer Hybrid 355.....	51.8	75.1	63.5
Wisconsin Hybrid 525.....	53.4	64.3	58.9
Wisconsin Hybrid 645.....	59.8	78.8	69.3
Iowa Hybrid 931.....	69.6	67.0	68.3
Wisconsin Hybrid 625.....	53.0	75.8	64.4
Wisconsin Hybrid 606.....	53.6	73.0	63.3
Kingscrot Hybrid F. K.....	56.3	69.3	62.8
Iowa Hybrid 95.....	48.0	77.1	62.6
Ohio Hybrid K-23.....	50.8	71.5	61.2
Wisconsin Hybrid 570.....	51.4	68.0	59.7
Duncan Yellow Dent*.....	53.3	57.9	55.6
Funk Hybrid G-7.....	68.8	74.4	71.6
Pioneer Hybrid 322.....	57.4	76.3	66.9
Pioneer Hybrid 349.....	66.9	72.9	69.9
Michigan Hybrid 561.....	60.9	64.4	62.7

*Open-pollinated varieties.

trials there apparently was no difference. Pickett corn has proved widely adapted throughout central Michigan and, since Michigan 1218 is of identical maturity, it can be grown advantageously in the same territory.

A rather wide range of corn growing conditions is presented in central Michigan. In some locations and in favorable seasons corns as late as the Duncan variety can be matured and in this group Wisconsin 645 and Iowa 931 have the best record in these trials. Intermediate between Duncan and Pickett in maturity is a group which includes Wisconsin 531, Pioneer 355 and Wisconsin 525 with Wisconsin 525 showing to disadvantage in 1939. Wisconsin 525 also yielded less than Wisconsin 531 in both the Saginaw and Huron County trials.

The authors believe that in normal seasons central Michigan corn growers should not choose hybrids any later than Wisconsin 531 for grain production and in the northern sections of central Michigan or on the lighter soils corns as early as Michigan 1218 are preferable.

Saginaw Trials

The Saginaw County trials were conducted on the farm of Herbert Schmeige, Chesaning, Mich. Twenty-three lines tested in both Saginaw and Ingham counties matured fully as rapidly in the Saginaw trials as they did at East Lansing. Pickett corn has been generally accepted throughout this territory as regards its ripening characteristics. For those who prefer and who normally can ripen a variety slightly later, Wisconsin 531 appears to be satisfactory. Wisconsin 456 has proved no more productive than open-pollinated corn and has

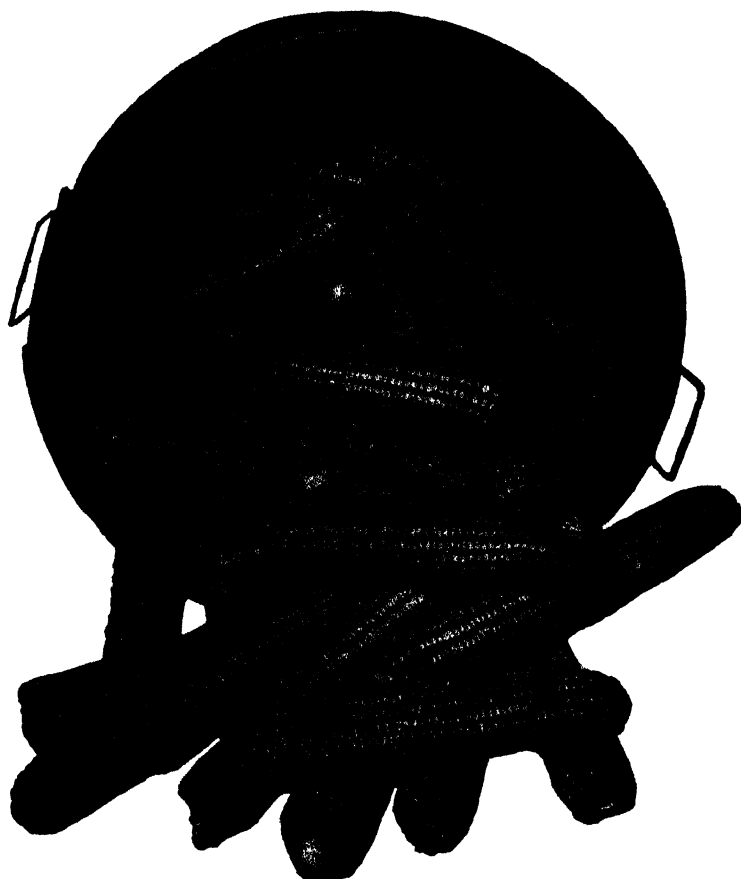


Fig. 2. Michigan Hybrid No. 1218.

Table 4. Average yield of varieties tested in Saginaw County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Kingscrest Hybrid D.....	71.5	58.2	64.9
Wisconsin Hybrid 404.....	59.7	54.8	57.3
Michigan Hybrid 1218.....	65.2	61.2	63.2
Pickett Yellow Dent (O. P.)*.....	61.7	57.8	59.8
Wisconsin Hybrid 531.....	77.4	59.1	68.3
Wisconsin Hybrid 525.....	70.0	59.3	64.7
Wisconsin Hybrid 456.....	64.8	53.4	59.1
Wisconsin Hybrid 570.....	79.7	64.1	71.9
Duncan Yellow Dent (O. P.)*.....	70.3	60.8	65.6

*Open-pollinated varieties.

given no indication of special value in this state. Wisconsin 570 and Duncan corns are normally later than is desirable in this section of Michigan.

As stated previously, the seasons of 1938 and 1939 presented unusually favorable conditions for ripening corn in Michigan. These conditions have been advantageous for the later maturing corns. This is illustrated in Table 5 taken from Saginaw County data covering four years rather than only the last two years. In 1938 and 1939 Wisconsin 570, a hybrid rather late for Saginaw, out-yielded Michigan 1218. However, in the less favorable seasons of 1935 and 1936 this later corn failed by a large margin to approach Michigan 1218 and was even considerably less productive than Pickett, an open-pollinated variety.

Table 5. A four-year comparison of two adapted and one late corn in Saginaw County.

Year of Trial	Michigan 1218 (adapted)	Pickett (adapted)	Wisconsin 570 (late)
1935.....	64.5 bu.	52.6 bu.	43.2 bu.
1936.....	65.9 bu.	51.2 bu.	41.0 bu.
1938.....	66.2 bu.	61.7 bu.	79.7 bu.
1939.....	61.2 bu.	57.8 bu.	64.1 bu.

Table 6 is presented to give a three-year comparison between two adapted hybrids and Pickett, an open-pollinated variety of similar maturity.

Table 6. A three-year comparison in Saginaw County of two hybrids and one open-pollinated corn of similar adaptation.

Year of Trial	Michigan 1218	Kingscrot D	Pickett
1937.....	79.0 bu.	73.5 bu.	62.3 bu.
1938.....	65.2 bu.	71.5 bu.	61.7 bu.
1939.....	61.2 bu.	58.2 bu.	57.8 bu.
Average.....	68.5 bu.	67.7 bu.	60.6 bu.

Huron Trials

In Huron County excellent conditions were provided for the hybrid corn trials on the farm of Herbert Gettel, near Pigeon. However, in 1939 yields were materially reduced on all varieties by a severe local hail storm in late July.

An earlier corn is required in Huron County than in either Saginaw or Ingham. Twenty hybrids required an average of nine days longer to reach 40% grain moisture than were required for the same hybrids at East Lansing in 1939. Michigan 1218 has consistently matured in the Huron County trials ever since 1935 but any corn later than Michigan 1218 or Pickett can hardly be considered dependable that far north. In fact, earlier rather than later hybrids should be considered by the

Table 7. Average yield of varieties tested in Huron County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Minnesota Hybrid 402.....	61.7	35.3	48.5
Wisconsin No. 25 (O. P.)*.....	56.5	36.9	46.7
Wisconsin Hybrid 355.....	68.5	34.8	51.7
Wisconsin Hybrid 404.....	64.5	37.0	50.8
Michigan Hybrid 1218.....	77.1	39.2	58.2
Pickett Yellow Dent (O. P.)*.....	69.5	36.8	53.2
M. A. C. Yellow Dent (O. P.)*.....	61.4	39.3	50.4
Golden Glow (O. P.)*.....	52.5	29.5	41.0
Wisconsin Hybrid 531.....	74.7	41.2	58.0
Wisconsin Hybrid 525.....	69.7	40.0	54.9
Wisconsin Hybrid 456.....	65.6	39.4	52.5

*Open-pollinated varieties.

average corn grower of that locality. As an average for 1938-39, no variety tested has out-yielded Michigan 1218 in the Huron County trials.

Wexford and Otsego Trials

To a considerable extent, the trials in Wexford County on the farm of William Franke, Tustin, Mich., and in Otsego County on the farm of Tom Millbocher, Johannesburg, Mich., have indicated the same conclusions. In the earliest groups, Minnesota 402, a mixed yellow and white hybrid, has led the trials not only as an average for 1938 and 1939 but ever since the trials were started in 1935. Kingscrot E is a good early yellow hybrid of essentially the same yield and maturity as Minnesota 402. A group of Wisconsin hybrids, mostly numbered in the 300 series, have demonstrated excellent upstanding stalks but no marked difference in yield from that of Minnesota 402. All of them

Table 8. Average yield of varieties tested in Wexford County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn variety	Bushels of Grain per Acre		
	1938	1939	Average
Minnesota Hybrid 402.....	19.2	60.0	39.6
Kingscrot Hybrid E.....	22.4	55.1	38.8
Northwestern Dent.....	17.3	50.8	34.1
Wisconsin Hybrid 404.....	24.5	60.9	42.7
Wisconsin Hybrid 325.....	25.3	59.1	42.2
Wisconsin Hybrid 350.....	27.0	55.1	41.1
Wisconsin Hybrid 340.....	21.3	58.4	39.9
Michigan Hybrid 1218.....	25.5	60.7	43.1
Pickett Yellow Dent (O. P.)*.....	16.2	57.0	36.6

*Open-pollinated varieties.

Table 9. Average yield of varieties tested in Otsego County in 1938 and 1939. The varieties have been arranged in groups of similar maturity and listed, within each group, in order of yield.

Corn Variety	Bushels of Grain per Acre		
	1938	1939	Average
Minnesota Hybrid 402.....	34.4	46.7	40.6
Wisconsin No. 25 (O. P.)*.....	29.9	48.7	39.3
Kingscrot Hybrid E.....	26.6	46.3	36.5
Northwestern Dent (O. P.)*.....	25.8	34.6	30.2
Wisconsin Hybrid 325.....	44.7	47.8	46.3
Wisconsin Hybrid 355.....	34.9	51.9	43.4
Wisconsin Hybrid 340.....	34.9	45.8	40.4
Wisconsin Hybrid 350.....	28.9	47.4	38.2
Wisconsin Hybrid 404.....	27.5	47.5	37.5

*Open-pollinated varieties.

are somewhat later than Minnesota 402 and are unlikely to mature fully at the locations of these trials. They may have a place in more favorable corn growing locations of northern Michigan. Wisconsin 325 appears to be at least fully equal to any in this group which have been tested for more than one year.

Tables 10 and 11 are given to show the records of Minnesota 402 and Kingscrot E compared with open-pollinated corn in Wexford and Otsego counties over a longer period of years.

Table 10. Yields of corn varieties which have been in Wexford County trials four years.

Years Tested	Kingscrot E	Minnesota 402	Wisconsin 350	Northwestern Dent
1936.....	22.3 bu.	19.7 bu.	15.7 bu.	17.9 bu.
1937.....	48.9 bu.	47.3 bu.	37.6 bu.	36.1 bu.
1938.....	22.4 bu.	19.2 bu.	27.0 bu.	17.3 bu.
1939.....	55.1 bu.	60.0 bu.	55.1 bu.	50.8 bu.
Average.....	37.2 bu.	36.6 bu.	33.9 bu.	30.5 bu.

Table 11. Yields of corn varieties which have been in Otsego County trials four years.

Years Tested	Minnesota 402	Wisconsin No. 25 (O.P.)	Kingscrot E	Northwestern Dent
1936.....	38.5 bu.	45.5 bu.	36.3 bu.	28.3 bu.
1937.....	58.8 bu.	48.5 bu.	47.5 bu.	43.1 bu.
1938.....	34.4 bu.	29.9 bu.	26.6 bu.	25.8 bu.
1939.....	46.7 bu.	48.7 bu.	46.3 bu.	34.6 bu.
Average.....	44.6 bu.	43.2 bu.	39.2 bu.	33.0 bu.



Fig. 3. Minnesota Hybrid No. 402.

Safeguarding Hybrid Seed Purchasers

The following provisions of the Michigan seed law, administered by the State Department of Agriculture, are designed to help safeguard the interests of purchasers of hybrid seed.

"Section 13, P. A. 34, 1937. HYBRID SEED CORN. The use of the term "Hybrid" in connection with seed corn offered or exposed for sale shall be restricted to first-generation stock of a cross, the parentage of which involves one or more inbreds.

"In addition to the labeling requirements specified in section two, of this Act,

every lot, package, parcel or bag of seed corn sold as hybrid seed shall have plainly written or printed on the tag or label, in the English language, the name or number by which the hybrid is designated.

"The vendor of the seed shall be responsible for there being on file with the Commissioner of Agriculture, a statement giving the pedigree of the hybrid and the name of the breeder who developed each inbred line involved in the cross."

Second-generation seed, even though the cross may have been excellent in the first generation, is decidedly inferior and should be avoided. Also, in making a first-generation cross, very thorough and complete detasselling of the seed-bearing line must be practiced. Finally hybrid seed, as well as other corn, must be carefully dried and handled in storage to insure strong healthy germination. To insure a high standard of excellence in all these particulars the Michigan Crop Improvement Association certifies the seed of certain hybrid varieties basing this certification on inspection of both the growing crop, while it is being detasselled, and the final shelled and graded seed.

The following hybrids have proved their merit for certain sections of Michigan, the Michigan State College has parent stock for controlled distribution, and seed certified by the Michigan Crop Improvement Association is available for planting in 1940.

Minnesota 402: A yellow and white, early hybrid developed by the Minnesota Agricultural Experiment Station. As yet it has not been surpassed in yield in northern Michigan trials.

Michigan 1218: A medium early hybrid developed by the Michigan Experiment Station. It matures regularly as far north as Huron County. Michigan 1218 has an unusually high shelling percentage with a comparatively slender cob; hence its stalks, while stiffer than those of most open-pollinated corn, are surpassed in stiffness by some other good hybrids. As yet the authors have not found hybrids of comparable maturity which surpass this line in yield of grain.

Wisconsin 606: This hybrid is comparable with the old Duncan open-pollinated variety in yield and maturity but markedly superior to Duncan and other open-pollinated varieties in stiffness of stalks and vigor of root growth. It was developed by the Wisconsin Agricultural Experiment Station.

Wisconsin 645: This hybrid, also developed by the Wisconsin Station, was formerly listed as being slightly later than Wisconsin 606. Additional maturity records and the experience of Michigan growers have indicated that this hybrid is no later than Wisconsin 606, is equal to it in stiffness of stalk, and probably somewhat superior in yield.

Michigan 561: This Michigan hybrid has been surpassed by several of more recent development in yield and quality of grain but it remains one of the best for silage as far north as Huron County.

CAUSES FOR COW REMOVALS IN MICHIGAN HERDS UNDER TEST IN DAIRY HERD IMPROVEMENT ASSOCIATIONS

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In 1850 there were about 100,000 cows kept for milk producing purposes in Michigan. The business of dairying revolved largely around a family cow and a home dairy trade. Cows calved in the spring, gave a small volume of milk for a short time during the pasture season and rested. The principal dairy products produced at that time were butter and cheese made largely on the farm. Cows according to the 14th U. S. Census produced annually about 1,400 pounds milk or about 60 pounds of butterfat.

Michigan dairymen now keep approximately 905,000 cows on 160,000 farms (1). The business of dairying today is largely commercialized, for over 80 per cent of the milk produced is either utilized as milk or butterfat (2) off the farm and processed commercially. The average yield of all Michigan cows is about 4,800 pounds milk and 190 pounds butterfat annually. The product of the farm dairy herd accounts for about 40 per cent of the total cash income of Michigan farmers (9).

The continuation of this favorable source of cash income by Michigan farmers depends largely on the quality of the dairy inheritance used by farmers, the rate of reproduction and the healthfulness of all Michigan cattle.

Records from Michigan dairy herd improvement associations show that the causes for removing cows are numerous and serious. The most common causes reported by the cow tester each month to the dairy extension office, Michigan State College, include; Group A—low production, udder trouble, sterility, Bang's disease, old age, bloat, other reasons; Group B—sold for dairy purposes.

Dairymen are probably not aware of the seriousness of the cow losses suffered because a record of the removals in many herds have neither been kept nor analyzed.

Cow testers visit the same 24- to 26-herd owners twelve times a year at monthly intervals, keeping milk production and feed cost data. The owners are supplied appropriate books and forms on which the supplemental data about cow losses are systematically recorded and reported. The cow testers began gathering the data first in 1931 and six years' data are now available.

The average number of cows under test varied slightly each month during the years reported, owing to new herds beginning or discontinuing the test, thereby causing a variable number of cows reported each month. This variable number of cows reported monthly was averaged for the year.

Cows removed because of low production were cows which the cow tester and the dairyman concluded to be unworthy breeding ani-

mals (either grade or registered animals) and unprofitable dairy cows, (those which would not make 250 or more pounds of butterfat yearly). The average fat production of all cows under test in Michigan Dairy Herd Improvement Associations since 1932 has been 330 pounds butterfat.

Udder trouble usually meant a condition of the udder which the owner deemed serious enough to cause him to remove the cow permanently. The owner no doubt concluded that he should neither (a) keep the cow any longer for breeding purposes, (b) sell the cow's product, nor (c) take the risk of spreading disease from the infected animal.

Cows removed because of sterility were those which had failed to conceive after being bred repeatedly and which no longer produced a large quantity of milk. They were cows which the owner concluded probably would not become fecund again. The majority of such cows were not examined by a veterinarian, although the dairymen included in this study, in many instances, are well versed in their profession and in some instances had benefit of regular veterinary service.

Removals because of Bang's disease included the positive Bang cows which had been tested in the federally conducted state Bang's test, and also actively aborting cows.

Cows which died were animals which were found dead or died suddenly from both natural and unnatural causes or "hardware" disease.

Old age was defined as to aged condition of the animal when desirable milk production and reproduction ceased.

Bloat when undiscovered soon enough causes death and included all such cows which died from this condition.

"Other reasons" was defined to include all other odd or infrequent causes for cows to be removed from the milking herd. It included cows struck by lightning and T. B. reactors, poisoned, hit by train or by auto, broken leg, and other numerous possible causes.

The causes in Group A generally resulted in a definite economic loss, either wholly or partially to the dairyman.

Cows were also lost by or removed from dairy herds when they

Table 1. Total cows under test and removal causes.

	1931-32	1934-35	1935-36	1936-37	1937-38	1938-39	Totals
Average No. Cows under Test during year	6,894	12,450	15,526	20,403	24,062	25,923	105,258
Total Cows Removed	1,202	1,563	3,762	5,600	6,228	7,094	25,449
Per cent Cows Removed . . (%)	17.4	12.5	24.1	27.4	25.8	26.8	24.1
REMOVAL CAUSES:							
Group A—Low Production	642	553	1,380	2,406	2,524	2,946	10,451
Udder trouble	104	68	221	677	654	762	2,486
Sterility	94	71	201	278	304	402	1,350
Bang's	91	297	536	391	570	549	2,434
Died	37	65	153	303	362	367	1,287
Old Age	52	49	84	130	145	164	624
Bloat . . . . .	.....	21	39	25	32	23	140
Other reasons	29	193	287	227	203	297	1,236
Group B—Dairy purposes	153	246	861	1,163	1,434	1,584	5,441

were sold for dairy purposes as desirable breeding and milk producing cows. Such cows—Group B—were usually sold for gain and economic advantage by the herd owner.

Table 1 reveals that a total of 105,258 cows were included in this 6-year study. Since so many of the same herds were under test continuously, it would mean that the majority of the cows were reported several times, representing several years for each animal.

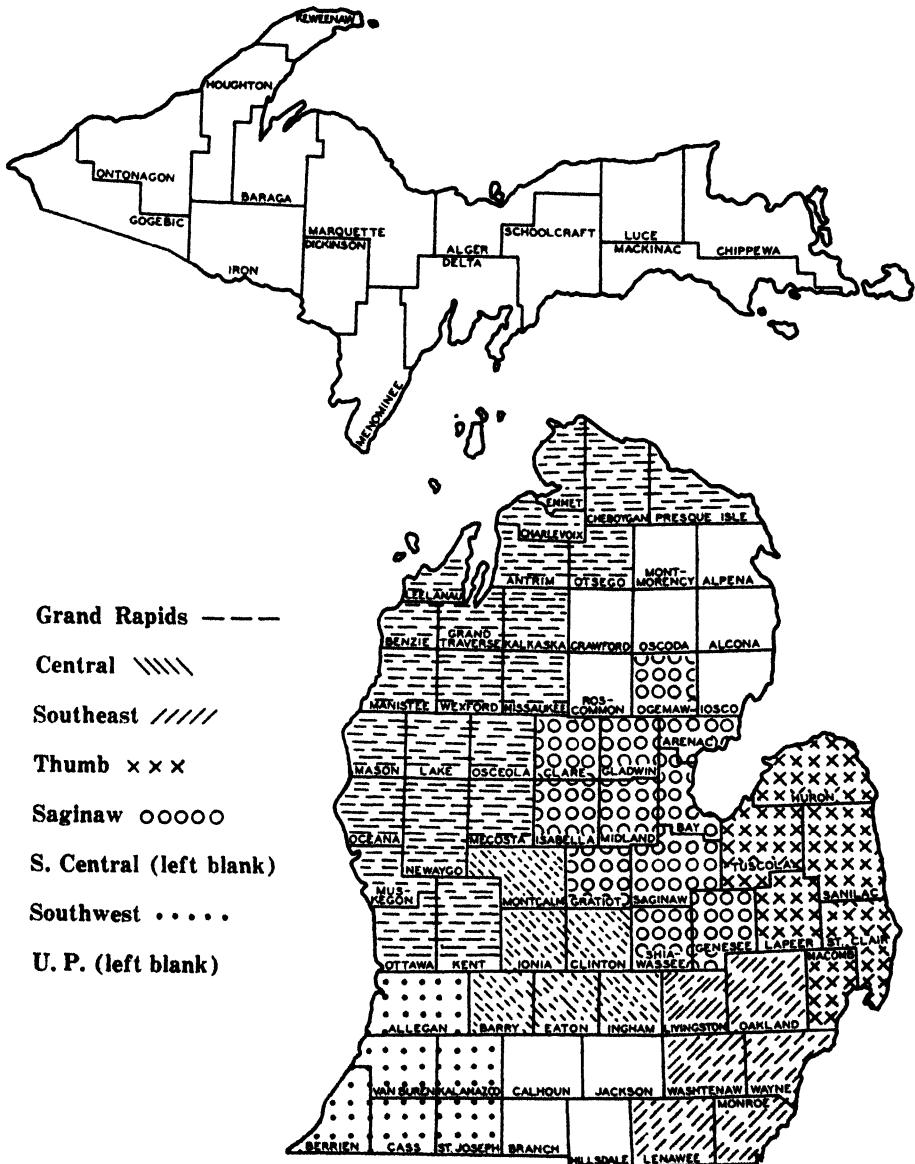


Fig. 1. Map showing counties included in districts.

Figures in this table also disclose that 25,449 cows were removed during the 6 years, or 24 per cent of the total. For the cows included in Group A, the removal rate was 19 per cent or 20,008 cows removed of 105,258 reported.

The figures indicate that many of the cows removed on the average never reached maturity, which in dairy cows is about 7 years. A study of the figures reveals that the average milk producing life of a Michigan D. H. I. A. cow, if all factors are included, is about 3.7 to 4 years (10). These data would indicate that a dairyman might expect a cow freshening at two years to be all through as an economical milk producer when six years old. The data indicate that a dairyman must plan to reproduce his herd promptly because at 3.7 years, lifetime expectancy of usefulness, only 1.85 years are probable as a source of supply for each heifer and bull calf. Since the heifers are the source of supply for future milk cows, the margin for replacement is comparatively narrow, especially if the calving interval is more than 12 months and if only a low calf loss of 10 per cent is experienced annually.

A further analysis of the removal factors according to geographic location in the state has been prepared in Table 2. This table covers the last two and one-half years (from June 1937 to December 1939) of the data in Table 1. It shows the removals which occurred by districts.

Table 2 shows the same data by percentages. It is evident that the percentage removed because of low production varies from the high in the Upper Peninsula with 67 per cent to the low in the Central district with 48.8 per cent. The Thumb district with 56 per cent, Southwest with 54 per cent, and Saginaw area with 53.5 per cent also showed above average for the state removals owing to that cause.

Table 2. Removal causes by districts for 2½ years, June 1937 to December 1939.

Districts	Grand Rapids	Central	South-east	Thumb	Saginaw	South Central	South-west	U. P.	Total
Low production	683	729	1,094	1,052	903	776	734	669	6,640
Udder trouble	229	272	302	237	219	225	157	95	1,736
Sterility	139	121	151	93	102	121	83	37	847
Bang's	92	127	344	186	149	189	144	64	1,295
Old age	42	42	57	56	53	31	46	39	366
Died	97	121	161	139	125	83	113	50	888
Bloat	8	8	13	22	11	7	1	8	78
Other reason	74	71	174	85	125	68	85	41	623
Dairy purposes	610	500	366	535	439	251	610	273	3,584
Total	1,974	1,991	2,562	2,404	2,126	1,751	1,973	1,276	16,057
Group A totals	1,364	1,491	2,196	1,860	1,687	1,500	1,361	1,003	12,473

The combined percentages of removals because of udder trouble, sterility and Bang's were smallest in the Upper Peninsula with 19.5 per cent or about 50 per cent of the highest reporting districts, Southeast with 36.6 per cent, and South-central with 35.7 per cent.

Removals due to bloat were least in the Southwestern district with only one animal reported. On the other hand, the Thumb district showed

Table 3. Removal causes by percentage for group A, by districts according to Table 2.

Districts	Grand Rapids	Central	South-east	Thumb	Saginaw	South Central	South-west	U. P.
Low production.....	50.7	48.8	50.0	56.0	53.5	51.7	54.0	67.0
Udder trouble.....	16.7	18.2	14.0	13.0	13.0	15.0	11.5	9.5
Sterility.....	10.2	8.1	7.0	5.0	6.0	8.1	6.0	3.6
Bang's.....	6.7	8.5	15.6	10.0	9.1	12.6	10.5	6.4
Old age.....	3.2	3.0	2.5	3.0	3.0	2.1	3.0	3.8
Died.....	7.1	8.1	7.0	7.0	7.4	5.5	8.0	5.0
Bloat.....	0.6	0.5	0.6	1.2	0.6	0.5	..	0.7
Other reason.....	4.5	4.7	3.3	4.8	7.4	4.5	6.0	4.0

22 animals lost, a removal rate twice larger than most other sections of the state.

The map shows the counties included in each district named in Tables 2 and 3. By expressing in percentages the removal causes experienced in Group A, these data show that 52 per cent of the removals were due to low production, Table 4.

Table 4. Showing total removal causes by percentage in groups A and B and group A alone.

	1931-32	1934-35	1935-36	1936-37	1937-38	1938-39	Av. Per Cent for 6 Years
Av. number cows under test	6,894	12,450	15,526	20,403	24,062	25,923	....
Total cows removed from Groups A and B	1,202	1,563	3,762	5,600	6,228	7,094	.....
Per cent removed	17.4	12.5	24	27.4	25.9	27.3	24
Total cows removed, Group A	1,049	1,317	2,901	4,437	4,794	5,510	19
Per cent removed	15.2	10.6	18.7	21.7	19.9	21.2	....
Per cent removals by cause based on total removals under Group A	%	%	%	%	%	%	%
Low production	61	42	47	56	53	54	52
Udder trouble..	10	5	8	15	14	14	11
Sterility.....	9	5	7	6	6	7	7
Bang's.....	9	23	18	9	12	10	13
Died.....	3	5	5	6.5	7	6	5
Old age.....	5	3	3	2	3	3	3
Bloat.....	..	2	2	5	1	5	1
Other reasons..	3	15	10	5	4	5	7

Losses of cows ascribed to death, old age, bloat, and other reasons probably cannot be reduced because they are largely natural and unavoidable.

Losses due to udder trouble, sterility and Bang's disease amounted to 31 per cent and may lend themselves to reduction or may be prevented. The sum of those causes, however, does not account for as many removals as are experienced by the dairymen from low production.

The data show definitely that the majority of the losses in six years in those herds were due to low production. During the six years, 10,451 cows of 20,008 cows lost or 52 per cent of the removals were due to low production.

Reducing Removals Due to Low Production

The following suggested measures are made to help dairymen reduce the removals due to low production. They may help a dairyman save time, effort and money in maintaining a smaller number of unprofitable cows.

Selection of Sires—Dairymen should strive to select more sires by progeny test and cooperate to use them more effectively. Sires and sons of sires proved to have desirable milk and butterfat percentage test in the progeny in the standard ear tagging 305-day dairy record project now in use nationally are listed annually in official publications from the United States Department of Agriculture (3). These publications should be considered by dairymen as a means to assist in promoting better inheritance. Selecting sires on the basis of dam and daughter comparisons will reveal to the dairyman the probable productiveness in milk and percentage test of the progeny of sons of such sires. Selecting sires on a basis of high consistent production in the majority of his sisters is a much more desirable method than basing the selection of the sire on either type alone or the size of a single record of the dam. If the proved sire known for his consistently good performance in all of his daughters is available in a dairy herd improvement association or other production testing group of dairymen, dairymen should cooperate within a breed to use such a sire in properly organized artificial insemination circuits. If such a sire is not available then dairymen should seek out his sons because they carry the same general genetic makeup as his daughters which have proved themselves under a herd testing project.

Selection of Females—More care in selecting healthy acceptable type and productive dams—at least equal to the breed average in milk and butterfat percentage test—is needed. Breeding from cows which display physical weaknesses and with low milk and butterfat inheritance, even though registered, is likely to prove disastrous and expensive.

Improved Pastures and Better Quality of Roughage—The use of better quality roughage—both pasture and alfalfa hay—will improve the health and the productiveness of the animal and increase the profits. Roughages are the natural feed for cows (5). Feeding larger amounts of better quality hay (6) will keep cows in better thrift and allow satisfactory milk production. Feeding bonemeal (4) will improve herd health and reduce losses.

Management—Employing good management designed to develop prevention rather than cure will prolong the lifetime period of usefulness. Controlling mastitis (7) and employing effective measures for Bang's disease control (8) will pay increased net profits by reducing cow losses. Milking mastitis cows last and using abundant bedding during the winter will reduce losses and improve conditions for disease resistance. Greater sanitation will help prevent cow removals.

In conclusion, these data point out that Michigan farmers have a cow replacement problem which is serious. Ways and means employed to reduce the removals in volume or to retard the rate of removals would effect savings and increase the annual margin of credits per cow (9).

The rate of removal because of diseases apparently varies in different districts of the state. Where the concentration of cows is greatest and market milk is produced, disease removals are greatest. Losses due to inheritance are heavy in all regions and this factor of building higher and more consistent production inheritance in all cattle is common to every district of the state.

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REFRIGERATED FOOD LOCKERS IN MICHIGAN

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The rapid expansion of local refrigerated locker plants is one of the outstanding recent developments in food storage and distribution. A large portion of these plants are of recent construction and provide cold storage lockers to individuals for the preservation of meats, poultry, fruits and vegetables. The locker has been described as a safety-deposit box kept in a room with a temperature near zero, where the family may store frozen foods grown at home or purchased at wholesale prices. This movement has spread into Michigan during the last two years and it is the purpose of this article to bring to the attention of people in this state the present status of the movement, and to report the findings of a recent survey of plants located in Michigan.

Brief History of Locker Plant Development in U. S.

According to Mann (1) the rise of the locker plant service started at Chico, Calif. about 1903. A local ice plant first rented upstairs cold-storage space to local merchants for storing eggs, apples, and other produce. In 1908 the service was extended to farmers for the storage of meat in boxes. Each farmer furnished his own box and the

boxes were stacked in a store room. The inconvenience of this arrangement and occasional loss from pilferage led to covered boxes that could be locked which were installed in 1913. The service was further expanded in 1917 and special storage rooms were provided.

In 1917, an ice plant manager in Centralia, Wash., furnished space in his cold storage room to some of his friends for the freezing and storage of wild game. This method was so successful that the service was extended to farmers who wished to store home-killed meats. About 10 years later at Walla Walla, Wash., a local dairy plant permitted farmers to freeze rabbits and other game in the butter storage room of the creamery. This proved so popular that the creamery provided



Fig. 1. Chill room with a refrigerated locker storage plant. The warm carcasses are cooled and aged at 33° F. before they are cut and wrapped for sharp freezing.

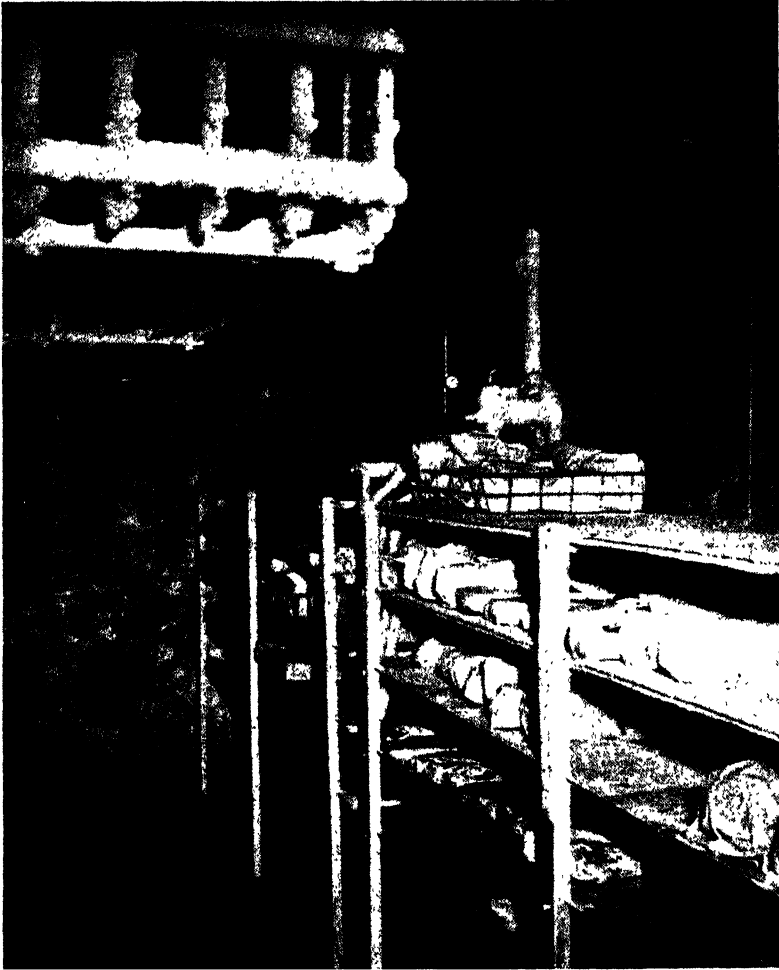


Fig. 2. The sharp freeze room is maintained at -20 to -25° F. The wrapped cuts of meat, packaged fruits, and vegetables are frozen quickly on the metal plate freezing units.

individual lockers for its patrons, who in 1938 numbered about 1,400 in a city of 16,000 population.

During the 10 years 1920-29 a limited number of plants were installed, but it was not until 1935 that locker plants were introduced extensively in the Middle-West. According to Mann (1) in 1938 there were 200 plants in Iowa, 200 in Washington, 62 in Minnesota, 41 in Wisconsin, and 40 in Illinois. A recent survey in Minnesota (6) reports that 3 plants were constructed in 1935, 4 in 1936, 30 in 1937, 60 in 1938 and 21 in 1939, making a total of 118 plants. The estimated capacity of these plants is more than 51,000 lockers or sufficient capacity to serve one-fifth of all the farm families of that state. In Wisconsin the rise of locker plants started in 1929 and by 1939 a total of 177 plants

with a capacity of 27,000 lockers were in operation. Similar data are reported from other middle-western states and since 1937 the movement has spread east of the Mississippi River and into the southern states. One of the trade papers (8) estimates that there are now 1,000,000 locker plant patrons in the United States.

The Lay-Out of a Typical Locker Plant

The services rendered and the individual plant lay-out varies from one plant to another but a typical complete service plant consists of four or five main rooms, in each of which a separate service is rendered. The general plan calls for a chill room where meat is chilled to remove all body heat and aged before being cut and frozen. The chill room is usually maintained at 32° to 36° F. When the carcasses have been chilled and aged for several days they are transferred to a cutting or processing room where they are cut in roasts, steaks, chops, etc. After cutting and wrapping, the individual cuts are placed in the sharp freezing room where they are quickly frozen solid at temperatures from -10° F. to -25° F. After freezing for 8 to 10 hours, the cuts of meat or the fruits and vegetables are transferred to the individual storage lockers located in the locker room where temperatures of 0° F. to 10° F. are maintained. In all plants built during the last few years the lockers are of steel construction and are arranged in tiers or banks in the locker room. The tiers are five or six lockers high and the lockers next to the floor are drawers equipped with rollers so that they can be pulled out conveniently. Each patron has a key to his individual locker and the plant operator has a master key to all lockers. The lockers vary in size, but the most popular sizes are 20 inches wide by 17 inches high and 30 inches deep, in tiers 5 high; and 20 inches wide by 15 inches high by 30 inches deep, in tiers of 6 units high. The capacity of each locker is from 200 to 250 pounds.

In addition to the rooms already described, most plants have a small office and machinery and supply rooms. Many are equipped to render lard, blanch vegetables, cure meat, and to perform other services. The lockers are rented on a monthly or yearly basis and small charges are made for the various services rendered.

Report of Michigan Survey

During the fall of 1939 the writer sent a questionnaire to all Michigan county agricultural agents. The data here reported were taken from the returned questionnaires and from additional information obtained directly from locker plant operators.

At present there are 29 refrigerated locker plants in operation in Michigan with a total locker capacity of 7,500-8,000 lockers. At least 18 of these plants were constructed during 1939. The location of the plants is shown in Fig. 4. They are more or less concentrated in the central part of the Lower Peninsula with the greatest number in the so-called Thumb area.

The size of the plants, as indicated by their locker capacity, ranges from small plants with 25 lockers to one recent installation of 600 units. Of the 28 plants reporting only two have fewer than 50 lockers, six fewer than 150, 22 with from 200 to 500 units, and one plant with



Fig. 3. The locker storage room is held at 0° F. The frozen products are stored in the individual lockers.

600 storage lockers. The average number of lockers for the 28 plants is 272 units.

The rental charges for individual lockers vary widely. In some of the older plants where small lockers of wood and hardware cloth construction prevail, the annual rentals range from \$5 to \$8 per locker. The newer plants equipped with sanitary steel lockers charge from \$10 to \$15 per year, depending on the size and location of the unit. Most of the newer plants reported that the average size locker was rented for \$1 per month, or \$10 to \$12 per year. In general, the lower locker of a tier is of the drawer type and rents for from \$1 to \$3 a year more than the standard type. The average annual rental for the 25 plants reporting was \$11.57.

Twenty-seven of the 29 plants were owned and operated by independent operators or corporations, while two are owned and oper-

ated as cooperatives. Only 10 of the plants are operated as separate businesses, while 17 are operated as sidelines to ice manufacturing plants, ice cream plants and stores, apple storages, dairies, meat markets, and grocery stores. The smallest number of lockers from the group of plants operated as separate units was 200 and the largest 600 units, with an average of 345 lockers for the group. Of the 17 plants operated as sidelines the smallest installation was 24 units while the largest was 380 with the average for this group at 215 units.

A large portion of the revenue from locker plants comes from charges from services rendered other than the rental from service lockers. These services are performed by a regularly employed butcher and the manager of the plant. A fixed charge, on a per pound basis, is made for each of these services.

All companies reported that they provided chill room services for the chilling and aging of meats and all were equipped with sharp

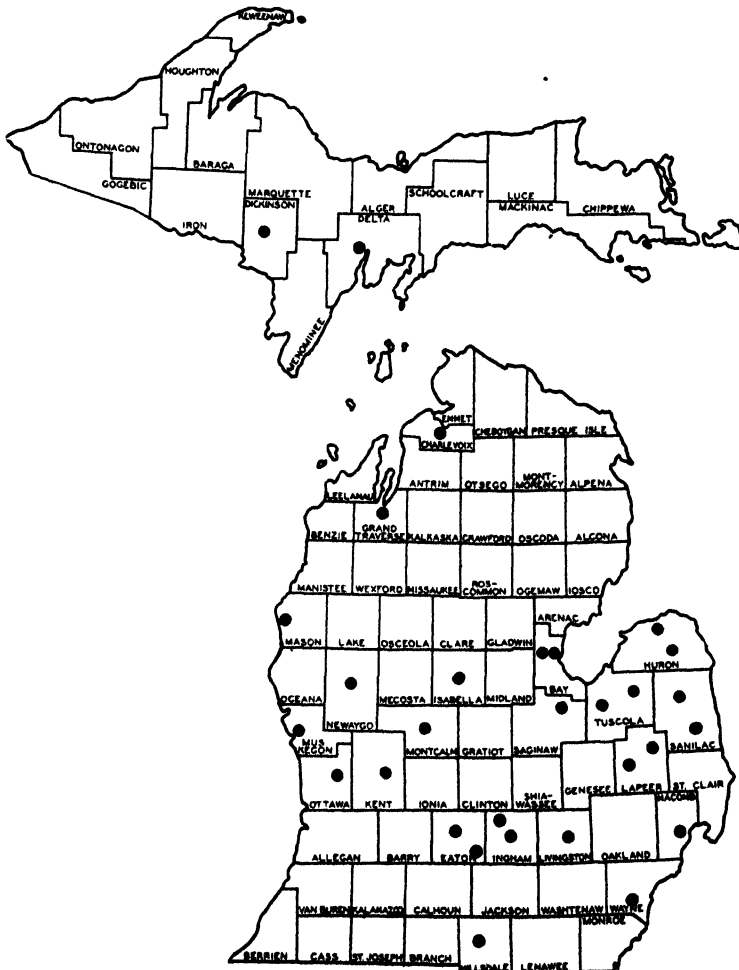


Fig. 4. Each dot on the map indicates the location of a locker storage plant.

freezing rooms and storage lockers. Twenty-four of the plants cut and wrap meat for their patrons and 23 grind meat and sausage. Fifteen are equipped to render lard and 16 smoke and cure hams and bacon. Seventeen provide butcher service for their patrons. Some of these plants maintain slaughter houses but most of them send the butcher to the patron's farm to perform this service. All but one of the 28 plants indicated that they do or intend to quick-freeze fruits and vegetables. Whether they are equipped to blanch and package those products was not indicated. Most of the plants keep a supply of wrapping papers and containers for resale to patrons. Seventeen of the 25 plants reporting, stated that they resold commercially frozen products to their patrons.

It is difficult to predict just how far the locker plant movement will expand in Michigan. However, it seems reasonable to expect further expansion during the next few years. The freezing and storage of fruits, vegetables, meats, poultry and other products in refrigerated locker plants involve problems not encountered in the older and more familiar processes of food preservation. Several divisions of the Michigan Agricultural Experiment Station are now actively engaged in investigating certain of these problems and during the near future will be in a position to make recommendations. Numerous other state and federal experiment stations are conducting similar investigations and the following list of selected references is given for those interested.

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SUDAN GRASS SEED PRODUCTION UNDER MICHIGAN CONDITIONS

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FARM_CROPS_SECTION

Occasionally Michigan farmers become interested in the production of Sudan grass seed and request information concerning the best methods to follow. One of the first questions usually asked concerns the methods of planting.

Sudan grass seed was planted on the Farm Crops farm at East Lansing on May 20 using six different distances of spacing of the rows. The first method consisted of drilling the seed with the disk grass and clover seed drill, spacing the rows 4 inches apart. In the second method, the grain drill was used, all holes open, and the rows were spaced 7 inches apart. The third method consisted of plugging every other hole and spacing the rows 14 inches apart. In the fourth method, the holes were so plugged that the rows were 21 inches apart; in the fifth the holes were 28 inches, and in the sixth, 35 inches apart. The grain drill was set to sow at the rate of 2 pecks of wheat per acre, which in this case delivered 23 pounds of Sudan grass seed per acre, in case of the rows being 7 inches apart. A relatively smaller amount of seed was sown when the rows were 14, 21, 28 and 35 inches apart. The highest yield of seed was obtained from the area where the rows were 7 inches apart. Results of the various spacings are shown in the following table:

Table 1. Yields of Sudan grass seed obtained per acre when the rows varied in width from 4 to 35 inches.

Width of Row (inches)	Yield of Seed (pounds per acre)
4.....	596
7.....	780
14.....	553
21.....	429
28.....	357
35.....	448

The weed problem was rather serious in the 14- and 21-inch rows, and not absent in the 28- and 35-inch rows, even though cultivation was practiced. No difficulty was experienced with weeds in the 7-inch rows. The growth of the stems was not so rank and coarse in the

7-inch rows as those spaced more widely apart, and this facilitated harvesting with the grain binder and also made threshing easier.

A planting was made to determine the influence of the amount of the Sudan grass seed sown per acre upon the yield of seed obtained when the rows were spaced 7 inches apart. The results of the various rates are shown in the following table:

Table 2. The influence of the amount of Sudan grass seed sown per acre upon the yield of seed obtained when sown in drill rows seven inches apart.

Pounds of Sudan Grass Seed Sown per Acre	Yield of Seed (pounds per acre)
5.....	549
10.....	603
15.....	585
20.....	750
25.....	786
35.....	794
45.....	768

The yield of Sudan grass seed did not increase significantly above the 20-pound per acre rate. Approximately 20 or 25 pounds of seed per acre would appear to be entirely sufficient.

Under Michigan conditions, sowing Sudan grass seed in 7-inch drill rows at from 20 to 25 pounds of seed per acre produced the maximum amount of seed, gave less trouble with weeds, required no cultivation and produced plants of sufficient fineness so that they could be harvested with the grain binder and threshed with the grain separator.

Sudan grass should not be stacked until the stems have dried thoroughly because of danger of heating and injury to the viability of the seed. The air-blast of the separator must be carefully regulated to prevent the blowing of seed into the straw pile.

The bulk of Sudan grass seed is grown in the southern Great Plains section where weather conditions are usually favorable for the production of seed of a bright color. Weather conditions are not always so favorable under Michigan conditions; nevertheless there are times when the price of Sudan grass seed is relatively high and there is need for an additional cash crop, so that the Michigan farmer is justified in producing seed of this crop.

CHESS OR CHEAT

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SECTION OF FARM CROPS

Chess or cheat is a winter-annual grass which, when sown in the fall or early winter, grows like the fall-sown grain crops, winter barley, rye, spelt and wheat. The various environmental conditions which cause these grains to go through their developmental processes also cause chess to pass through its developmental processes at the same time. It is on account of this similarity in life cycle that chess is found so frequently in fields of the fall-sown grains, particularly spelt, winter barley and wheat, and so seldom found in hay fields or fields of spring-sown crops.

The feeding value of chess hay cut at heading time or slightly before heading is similar to that of other native grasses cut at a comparable stage of growth. Similarly, the feeding value of the hay drops rapidly as the stems become woody and the seed crop nears maturity.

Chess is undesirable in a grain crop because it is a direct competitor of the growing grain for whatever plant nutrients and moisture there are in the soil, thereby reducing the yield of grain; and, further, it reduces the quality of the threshed grain.

Control measures are based on the fact that **chess plants develop only from chess seed** and not from injured seedlings of other species. Chess cannot develop from any other kind of seed regardless of how that seed has been treated or what has been done to the growing plants, either in seedling stage or in later stages.

These control measures are chiefly of the preventive type and involve (1) the planting of chess-free seed of the winter grains rye, spelt, winter barley, or wheat, (2) the eradication of chess plants through the use of hay or spring-sown crops, and (3) the application of chess-infested manure only at the proper time in the crop rotation.

Chess-free seed of the fall-sown grains may be obtained in two ways, if the farm supply has chess in it. Clean seed may be purchased or the farm supply may be cleaned. The latter method requires careful and rigorous cleaning with perhaps two or three runs over the fanning mill, using a $9/64$ inch round hole bottom screen for barley, rye or wheat and a $3/32 \times \frac{1}{2}$ inch bottom screen for spelt. The top screen should have round holes and should be $14/64$ inch in diameter for rye and wheat, $20/64$ for barley and $24/64$ or $28/64$ for spelt. In addition to having a clean supply of seed at hand, care should be taken to **keep** the seed chess-free by thoroughly cleaning the sacks and grain drill. During or shortly after heading time the following spring, the field should be carefully inspected and all chess plants pulled up so that no mature seed will be formed to contaminate the harvested grain. At harvest and threshing time, thoroughly clean the combine or the binder

and separator. As a further precaution, do not use for seed the first 40-50 bushels of threshed grain. Repeat the thorough cleaning process each year, especially if a custom separator or combine is used.

A field infested with chess may be cleaned by not allowing any chess plants to go to seed. This can be done by using hay crops or spring-sown annuals for two years and being sure all fence rows are kept chess-free.

If chess-infested manure is added to the field it should be done just prior to a spring-sown crop such as corn. Do not apply chess-infested manure as a top-dressing on fall-sown grain as mild weather following the application may cause the chess seeds to sprout. Later cool weather may put these chess seedlings into their dormant stage so that as spring opens up they can produce a crop of mature seed.

To summarize: chess grows only from chess seed. To have grain and grain-fields free from chess, plant only chess-free seed, keep chess plants from maturing, either by roguing or by cutting, and apply manure which contains chess seed just prior to a spring-sown crop.

EFFECT OF ALFALFA-BROMEGRASS PASTURE ON THE FLAVOR OF MILK WHEN THE COWS ARE MILKED THREE TIMES DAILY

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SECTIONS OF DAIRY HUSBANDRY AND FARM CROPS

During August 1939, cows that were milked three times daily and pastured on a mixture of alfalfa and smooth brome grass produced milk with a definite objectionable flavor. This was not the case when the cows on the same pasture were milked twice daily. The bottled pasteurized milk from the College Creamery had a flavor which customers described as "barny," "barnyard," "soda," and "washing powder". The customers did not identify it as a "feed" flavor. The milk had a decided alkaline, soda-like, or neutralizer taste, which was very offensive and nauseating, whether drunk cold or at ordinary luke warm temperatures.

Since the day-old milk showed by standard plate method a bacterial count of only 2,950 colonies per ml. and direct microscopic examination of 50 fields revealed no bacteria, the milk apparently was of high quality from the bacteriological standpoint.

Because the flavor was evident only in milk from those cows that were milked three times daily, it was thought that possibly the management practices involving shorter pasturing periods previous to milking might have been responsible for the flavor.

A check-up on the feeding management showed that the only change in routine at the time when the flavor was evident had been in pastures. Formerly the cows had had access to Sudan pasture and then at the time of flavor trouble had been turned to an alfalfa-brome-grass pasture in its first productive year. The occurrence of the plants was about evenly divided, the alfalfa being about 15 to 18 inches high

and the bromegrass on the upland 6 inches in height and on the lowland 12 or more inches in height. Muck soil, predominating in the low places, seemed unfavorable to alfalfa because of winter-killing or otherwise, hence these areas were largely covered with pure bromegrass, intermixed with pigweed. Some light showers had brought forth quick growth of the bromegrass and the cows were reported to have been grazing chiefly on this bromegrass. In fact, the herdsman said that at milking time the cows would usually be found grazing on those low areas.

A flavor inspection of the cans of milk revealed that many of them were so strongly off-flavored that it was inadvisable to include them in the mixed milk to be pasteurized for bottling purpose. Segregation of those cans of off-flavored milk from the lot to be pasteurized resulted in a normal flavor in the pasteurized milk, thus indicating that the experienced flavor trouble in the bottled product was in large part due to the inclusion of the cans of off-flavored milk. In fact, when all the milk from the cows on the alfalfa-bromegrass pasture was mixed together and pasteurized, the pasteurized product was again distinctly off-flavored.

Several pasturing trials were therefore run to determine not only the specific flavor effect of this type of pasture on the milk but also to determine what changes in feeding management were necessary to prevent the off-flavors from gaining entrance to the milk, yet retaining use of the pasture. In these trials the off-flavors were recorded as feed flavor although they sometimes resembled more closely an alkaline flavor.

Comparison Between Alfalfa-bromegrass and Sudan Pasture

The first trial consisted in turning five cows that were being milked three times daily to the alfalfa-bromegrass pasture following the morning milking. The cows were turned to pasture about six hours prior to the next milking period. In addition, four other cows were turned simultaneously to a comparatively mature Sudan pasture on which cows had yielded milk free of off-odors. Both groups had access to the pastures up to time of milking.

Table 1. The intensity of feed flavor in milk from cows pastured on alfalfa-bromegrass and on Sudan grass pasture.

No. of Cow	Intensity* of Feed Flavor as Indicated by		Type of Pasture
	Judge A	Judge B	
1.....	+++	+++	Alfalfa—bromegrass
2.....	—	—	Sudan
3.....	+++	+++	Alfalfa—bromegrass
4.....	+++	+++	Alfalfa—bromegrass
5.....	—	—	Sudan
6.....	+++	+++	Alfalfa—bromegrass
7.....	—	—	Sudan
8.....	+++	+++	Alfalfa—bromegrass
9.....	—	—	Sudan

* +++ , very strong feed flavor
 ++ , distinct feed flavor
 + , slight feed flavor
 — , no feed flavor

Samples of milk from each of the nine cows were taken at time of milking, were keyed to disguise identity, and were examined organoleptically for flavor by two judges working independently. The results are presented in Table 1.

It was found that the milk from the cows which were on the alfalfa-bromegrass pasture had a very strong feed flavor whereas that from the cows not on this pasture had no feed flavor. There was perfect agreement between the judges in this respect.

The Effect of Alfalfa-bromegrass Pasture on the Flavor of Milk

In a second pasturing trial, the five cows were turned again to the alfalfa-bromegrass pasture following the morning and noon milking, but after the night milking were left in the stable. During the grazing period between the morning and noon milking, the grazing habits of the cows were watched closely to note if they had any preference for a particular species of plant or area on which to graze.

This observation showed (a) that the cows grazed continuously after turning to pasture for approximately two hours before noticeably letting up on grazing and (b) that the cows grazed entirely on the upland area where the alfalfa and bromegrass plants were estimated to be about equally divided. No particular preference was noted for either plant. Both seemed to be cropped at random to approximately the same extent.

Samples of milk were taken from each cow following each milking and scored "blind" for flavor. The intensities of the flavor criticisms are given in Table 2.

The night milk was found to have a more intense off-flavor than the noon milk, and the morning milk had no feed flavor. The lack of off-flavor in the morning milk may be explained by the fact that by the time of milking at least eight hours had elapsed from the time the cows had been taken from the pasture.

Theoretically, the cows had access to the pasture following the morning and noon milking for exactly the same length of time. However, their grazing habits may have differed sufficiently to account in part for the difference noted in the intensity of the flavors of the noon

Table 2. The intensity of feed flavor in milk from five cows having access to alfalfa-bromegrass pasture prior to the noon and night milking, but not prior to the morning milking.

No. of Cow	Intensity* of Feed Flavor in the		
	Noon Milk	Night Milk	Morning Milk
30.....	+++	++++	-
41.....	+++	+++	-
73.....	+++	++++	-
108.....	+++	++++	-
115.....	+++	++++	-

++++, offensive, nauseating feed flavor, suggestive of soda neutralizer
 ++++, very strong feed flavor
 ++, distinct feed flavor
 +, slight feed flavor
 -, no feed flavor

and night milk as noted in Table 2 and subsequent trials. When the cows were turned to pasture in the morning they began grazing at once as they had been on a dry lot all night and were empty. Furthermore, the coolness of the morning seemed conducive to grazing. When the cows were turned to pasture after the noon milking they had been off the pasture not exceeding three to four hours at most and were not so empty as in the morning, hence were slow to graze. Also, they were turned to pasture during the late heat of the day under which conditions they seemed to prefer the shade of a tree rather than the open pasture. Grazing during this period came later, when the temperature was cooler. In fact, when the cows were brought in for the night milking, they were generally to be found still grazing.

Effect of Milking Routine When Cows Milked Three Times Daily Were Pastured on Alfalfa-bromegrass

Cows in this study had access to the alfalfa-bromegrass pasture prior to the noon and night milking, but not before the morning milking. As the milk was drawn, it was promptly cooled over a tubular cooler. When a can was filled it was set into the cooling room at 40° F. until delivered to the College Creamery at 7 a. m. Cream separation was done in the morning, the morning milk being used while yet warm, hence no morning milk was delivered. As the cans were filled they were tagged in the order of milking. Samples of each can were taken and examined for flavor. The results are given in Table 3.

Table 3. The intensity of feed flavor on each can of milk from cows on alfalfa-bromegrass pasture according to the order of milking.

Order of Milking (10-gal Cans)	Intensity* of Feed Flavor in the	
	Noon Milk	Night Milk
Cows milked three times daily		
1st can	++++	++++
2nd can	+++	+++
3rd can	++	++
4th can	++	++
5th can	+	+
6th can	+	+
7th can	No sample	++
Cows milked twice daily		
1st can	No sample	-
2nd can	No sample	-

++++, offensive, almost nauseating feed flavor, suggestive of soda neutralizer
 ++++, very strong feed flavor
 ++, distinct feed flavor
 +, slight feed flavor
 -, no feed flavor

These examinations showed that the flavor of the night's milk was very strong down to and including the sixth can and was distinct even in the seventh can. Of interest was the fact that at the time for the night milking the cows were still grazing. The first can of the noon milk had an offensive, almost nauseating feed flavor as did that of the

night milking. However, the following cans had less intense feed flavor, decreasing apparently with the milking period.

Of interest also in this examination and in subsequent trials was the fact that cows milked twice daily and grazed on alfalfa-brome-grass pasture yielded milk negative to feed flavor. Grazing immediately when turned to pasture, they evidently were able to crop sufficient nutrients at the fore part of the interval between milkings so that the deleterious flavor-producing substances would have passed off before the next milking.

Effect on the Intensity of Flavor of the Milk When Cows Had Free Access to a Mixture of Alfalfa-brome-grass Pasture Versus Confinement to an Area Chiefly of Brome-grass

Following the morning milking of August 25, 37 cows of the College Dairy Herd that were milked three times daily were turned onto the alfalfa-brome-grass pasture where they were permitted to graze as they wished. Observation showed that they grazed largely on the upland area.

After the noon milking they were turned into the same field but their grazing was confined to the low, muck area where the brome-grass was of luxuriant growth. Here the cows grazed rather steadily for about two hours, during which the area was trampled and cropped so much that the herd became almost unmanageable in their eagerness for new pasture. Although herded on this area by four men they finally broke through to the upland areas on which the alfalfa-brome-grass plants were about equally divided. Here they completed their fill, cropping both alfalfa and brome-grass. The Holsteins as a group were the last to stop grazing. When grazing ceased the cows were driven to the barn and milked within a period of two hours.

After the night milking they were left in the barn. Individual samples of milk were taken at each milking, cooled, and held at 40° F. until examined. The 111 samples in one-half pint bottles were shuffled to intermix the noon, night, and morning samples, after which they were judged "blind". The results are presented in Table 4.

When the cows were withheld from the pasture during the night no feed flavor was apparent in the morning milk. A similar observation was reported also in Table 2. Especially noteworthy was the fact that each of the morning samples, despite being intermingled with the noon and night samples at time of judging, could be segregated from the other samples by the sense of smell alone.

Some variations may be noted between the intensity of odor in the noon and night milk from the same cow. It is possible that this variation may be attributed to the inaccuracy of the sense of smell, which is very unlikely. A more plausible explanation, however, lies in the duration of the period between grazing and milking. It is possible that the cow grazing most heavily in the morning period may have grazed lightly in the afternoon period or *vice versa*. On the other hand it must not be overlooked that a change in milkers, between the noon and night milking might include the possibility of a longer milking period or a change in the order of milking, which, however, is generally fixed within limits. Regardless of which factor, the time between actual grazing and milking must have been affected.

Table 4. The intensity of feed flavor in milk from 37 cows that were milked three times daily when they had access to alfalfa-bromegrass pasture prior to the noon milking, were confined largely to pure bromegrass pasture before the night milking, but had no access to the pasture prior to the morning milking.

Cow No.	Breed	Intensity* of Feed Flavor in the		
		Noon Milk	Night Milk	Morning Milk
3.....	Guernsey.....	++++	+++	-
13.....	Guernsey.....	++++	+++	-
30.....	Guernsey.....	++++	+++	-
41.....	Guernsey.....	++++	+++	-
59.....	Guernsey.....	++++	+++	-
60.....	Guernsey.....	++++	+++	-
73.....	Jersey.....	++++	+++	-
90.....	Jersey.....	++++	+++	-
108.....	Jersey.....	++++	+++	-
115.....	Jersey.....	++++	+++	-
117.....	Jersey.....	++++	+++	-
146.....	Ayrshire.....	++++	+++	-
157.....	Ayrshire.....	++++	+++	-
152.....	Ayrshire.....	++++	+++	-
153.....	Ayrshire.....	++++	+++	-
157.....	Ayrshire.....	++++	+++	-
161.....	Ayrshire.....	++++	+++	-
186.....	Holstein.....	++++	+++	-
195.....	Holstein.....	++++	+++	-
231.....	Brown Swiss.....	++++	+++	-
232.....	Brown Swiss.....	++++	+++	-
234.....	Brown Swiss.....	++++	+++	-
236.....	Brown Swiss.....	++++	+++	-
248.....	Brown Swiss.....	++++	+++	-
252.....	Holstein.....	++++	+++	-
258.....	Holstein.....	++++	+++	-
261.....	Holstein.....	++++	+++	-
274.....	Holstein.....	++++	+++	-
278.....	Holstein.....	++++	+++	-
279.....	Holstein.....	++++	+++	-
280.....	Holstein.....	++++	+++	-
281.....	Holstein.....	++++	+++	-
300.....	Brown Swiss.....	++++	+++	-
301.....	Brown Swiss.....	++++	+++	-
302.....	Brown Swiss.....	++++	+++	-
303.....	Brown Swiss.....	++++	+++	-
305.....	Brown Swiss.....	++++	+++	-
Average.....		2.9**	2.4	0.0

* + + + +, offensive, almost nauseating feed flavor, suggestive of soda neutralizer

+ + +, very strong feed flavor

+ +, distinct feed flavor

+, slight feed flavor

-, no feed flavor

** + + + + = 4.0, + + + = 3.0, + + = 2.0, + = 1.0, and - = 0.0

Previous and later trials showed that the night milk had a more intense feed flavor than did the noon milk. However, the average feed flavor of the night milk in Table 4 was less intense than that of the noon milk. Theoretically, the intensity should be more, feed effects being the same, as the cows were grazing on the pasture almost up to the time of milking. It appears, therefore, by deduction that the effect of bromegrass pasture on the flavor of milk is not so pronounced as alfalfa pasture.

Effect on the Flavor of the Milk by Removing Cows from Alfalfa-bromegrass Pasture Three Hours Before Milking

Trials in which the "three-timer" cows were taken off the alfalfa-bromegrass pasture three hours before milking were effective in reducing the intensity of the feed flavor. However, the first two 10-gallon cans of milk drawn yet had a strong feed flavor, and not until the fifth or sixth can was milked was the off-flavor only slight.

Effect of Pasturing on Sudan Only After Having Pastured on Alfalfa-bromegrass

In the early afternoon of August 29 the "three-timer" cows were turned to good Sudan pasture after the noon milking. Samples of milk from each can were examined as before. In general, the flavor intensity decreased at least two levels in the successive cans following milking, from that previously noted when the cows were on the alfalfa-bromegrass pasture (Table 4). That is, the intensity decreased from "offensive" to "distinct" or from "strong" to "slight". However, the milk in general yet had a feed flavor. This flavor may have been contributed mostly by the alfalfa-bromegrass consumed in the morning grazing period because in routine grazing there seemed to be a cumulative effect shown by a greater intensity of feed flavor in the night milk.

In this connection, individual samples of milk were obtained at the night and morning milking from 22 "two-timer" cows of the Kellogg Farm, pasturing daily on good Sudan pasture. Feed flavor was not noted in any of the samples of morning milk but was detected as "slight" in two of the samples of night milk. A check-up on the grazing habits of these cows showed that invariably the entire herd was lying down when the attendant went to drive them in for milking, indicating the cows had had their fill of feed some time previously.

The Effect of Pure Bromegrass Pasture on the Flavor of Milk

A pasture trial was run at the Kellogg Farm to note the effect of bromegrass alone on the flavor of the milk. Four "two-timer" cows, deprived of feed for 4½ hours, were turned to a bromegrass pasture at 9:30 a. m. The bromegrass was of good growth but was not so luxuriant or so succulent as usually noted in the spring. When the cows had had their fill they were taken from the pasture and milked immediately. Milking was begun at 11:45 a. m., 2½ hours from the

Table 5. Effect of bromegrass pasture.

Cow No.	Intensity* of Feed Flavor in the Milk
24.....	++
26.....	-
34.....	+++
53.....	+++

* ++, very strong feed flavor
 +, distinct feed flavor
 -, slight feed flavor
 -, no feed flavor

time the animals were turned to the pasture. Samples of the complete milkings were obtained, cooled, and examined for flavor. No consistent effects on the flavor were noted (Table 5). The milk from two cows had a strong feed flavor, that from one cow a distinct feed flavor, whereas that from the fourth cow showed no feed flavor. The intensities of feed flavor seemed similar to that usually noted in the milk when the cows are first turned to bluegrass pasture in the spring. If brome-grass were a flavor contributor equal to alfalfa, an offensive, almost nauseating feed flavor might have been expected under those conditions as indicated from the results presented in Table 4 where the animals grazed within the 5-hour period prior to milking.

Effect of a Limited Grazing Period on Alfalfa-brome-grass Pasture Followed by Sudan Pasture

Giving "three-timer" cows access to alfalfa-brome-grass pasture for one and one-half hours following milking and then turning them to Sudan pasture was ineffective in preventing feed flavors in the milk. The first two cans of such milk had a strong feed flavor whereas that produced later had a distinct to a slight feed flavor. This practice, however, seemed to be effective in lessening the intensity of the off-flavor.

Effect of Supplementing Alfalfa-brome-grass Pasture with Alfalfa Hay

On September 1 the alfalfa-brome-grass pasture was supplemented with alfalfa hay, the cows given access to the hay at 5 p. m. following the afternoon milking, but not after the night milking. The comparison of the feed flavors noted is given in Table 6.

Table 6. Effect of supplementing alfalfa-brome-grass pasture with alfalfa hay.

Order of Milking	Intensity* of Feed Flavor When Cows Had Access During Intervals Between Milking to		
	No Feed	Alfalfa— Brome-grass Pasture	Alfalfa Hay at 5 p m., then Pasture
	Morning	Noon	Night
1st can	—	+++	+++
2nd can	—	++	++
3rd can	—	++	+
4th can	—	+	+
5th can	—	+	+

* + + +, very strong feed flavor
 + +, distinct feed flavor
 +, slight feed flavor
 —, no feed flavor

Effect of Supplementing Sudan Pasture with Alfalfa Hay and Corn Silage

By the first week in September the cows were receiving practically full rations of alfalfa hay, silage and concentrates, the alfalfa hay and silage being fed after milking. In addition during the day the cows had

Table 7. Intensities of feed flavor in mixed milk from a "three-timer" herd receiving corn silage, alfalfa hay and concentrates in addition to Sudan grass pasture.

Order of Milking	Intensity* of Feed Flavor in	
	Noon Milk	Night Milk
1st can.....	0.2	1.7
2nd can.....	0.2	1.0
3rd can.....	0.1	1.6
4th can.....	0.0	0.6
5th can.....	0.0	0.4
6th can.....	0.0	0.2

* +++=3 0, ++=2 0, +=1.0, --=0 0

access to a rather mature Sudan grass pasture. The cans of noon and night milk were examined daily over a 9-day period, the results of which are recorded in Table 7.

Discussion

From the various trials it seems apparent that alfalfa, whether as a pasture or as a hay, may have a pronounced effect on the flavor of the resulting milk depending on management. Notable also was the duration of the deleterious effects of alfalfa particularly when the cows were milked three times daily and had access to the feed only between two of the milkings.

That alfalfa is the cause of objectionable feed flavor in the milk is not new. Hoard's Dairyman (7) stated that when cows were fed alfalfa as the main ration there would probably be for a time a more or less peculiar flavor in the milk, although the flavor would not necessarily be an unpleasant one. Later (8), attention was called to complaints among cheesemakers that alfalfa gave the milk a flavor which affected the quality of cheese manufactured from it. The opinion was that such feeds as rape, rutabaga, clover, and sometimes alfalfa would result in objectionable flavor in the milk. In 1920 Hoard's Dairyman (9) answering the query "Will alfalfa pasture taint milk?" stated that the editors had never heard of any serious complaint due to pasturing alfalfa, but believed that it was quite possible when cows were first turned onto alfalfa that the milk would have a "grassy" flavor, which would soon disappear. Feeding alfalfa hay on the Hoard's Dairyman farm for more than 20 years without bad odors in the milk led them (10) to believe that alfalfa hay would not produce bad odors in the milk, although green alfalfa (either as pasture or soiling) or alfalfa silage might, particularly if fed within three or four hours of milking.

As early as 1922 Gamble and Kelly (5) pointed out that in some alfalfa sections of the United States the so-called alfalfa taste was general in milk and in those sections the milk was accepted without comment.

However, the intensity of the alfalfa feed flavor may be so strong as to be objectionable to the general milk supply. Gamble and Kelly (5) concluded from their feeding trials on legume silage, of which alfalfa was one, that legume silage affected the flavor and odor of milk to a greater extent than did an equal amount of corn silage.

Babcock (1) found that the feeding of green alfalfa to dairy cows at the rate of 30 pounds to each cow one hour before milking produced very pronounced off-flavors and odors in the milk. Increasing the time of feeding the green alfalfa to three hours before milking decreased the intensity of the off-flavors and odors, but did not eliminate them. He advised when using alfalfa as a soiling crop for dairy cows, to feed it after milking. When using alfalfa for pasture, he advised removing the cows from the pasture at least four or five hours before milking.

In 1926, Roadhouse, Regan and Mead (13) reported "Alfalfa in the form of hay, pasturage, or when fed green as a soiling crop produced a noticeable flavor in milk when fed within the five-hour period before milking, but pasturage or freshly cut alfalfa produced a more pronounced flavor than alfalfa hay." They found that during the first week after the cows were given access to alfalfa pastures, the flavor of the milk was objectionable from the consumer's standpoint.

Lucas (11) stated, "Alfalfa hay gives to milk a rather pronounced flavor, but it is objected to by only a very few people."

General experience has shown that the radical changing of feeds or feeding practices is likely to affect the flavor of milk adversely. Barkworth (1) in England pointed out, in connection with the deleterious flavor effects of feeding molassied beet pulp that there was some evidence that the cow's system became accustomed to the new foodstuffs so that after a few days the taint in the milk might disappear even if the same amount were fed.

However, Gamble and Kelly (5) observed that the level of feeding had a bearing on the elimination of the flavor. In feeding corn silage, they noted a less intense feed flavor in the milk as feeding progressed when feeding less than 35 pounds of corn silage per day but when 40 pounds per day were fed the sweetish feed flavor could always be detected.

Morrison (8) also reports: "When cows are first turned to pasture, a grass flavor is at once noticed in the milk, but this soon disappears, or else we fail later to notice it."

Eckles, Anthony and Palmer (4) advised that when cows are changed suddenly from dry feed to grass the milk may be given a strong taste but if the change is made gradually, little or no change in taste is noted.

Comparatively recent work substantiates the earlier findings that alfalfa hay fed to cows soon before milking adversely affects the milk flavor. Weaver and associates (12) (13) found that alfalfa hay had its worst effect on the flavor of milk when fed two hours before milking. When the alfalfa was fed four hours before milking, the flavor was entirely eliminated with some cows and so reduced as to be scarcely discernible with others. In fact, the investigators noted that the effect of the hay persisted in a slight degree with some cows as long as seven hours. They found that aeration would remove about one-half of the off-flavors imparted to milk by alfalfa hay.

Roadhouse and Henderson (10) observed that when the cows were receiving alfalfa hay as roughage and were given access to it immediately after milking they did not return to the feed racks and consume sufficient hay in the five-hour period before milking to affect seriously the flavor of the milk. The same was true when the cows

had access to alfalfa pasture both day and night. However, when they were given access to the pasture only during the interval between the morning and evening milkings, they consumed sufficient green alfalfa during the five-hour interval before milking to cause an objectionable feed flavor in the milk. The investigators recommended, therefore, removing the cows from the pasture four or five hours before milking if the feed flavor was to be avoided entirely. On the other hand, pasturing the cows on Sudan grass during the day did not cause an objectionable flavor in the milk.

Morrison (8) states that green alfalfa fed within 5 hours before milking may cause a pronounced flavor in the milk and even alfalfa hay fed less than 4 hours before milking may cause a noticeable flavor.

In view of the fact that cows milked three times per day yielded feed-flavored milk and that cows milked two times per day yielded milk free of feed flavor when allowed access to the same pasture, the recent work of Woodward (14) on the quantities of grass a cow would graze is of interest. He found that when the grass was tender and abundant and the weather cool that Jersey and Holstein cows in two trials grazed an average of 151 and 149 pounds of green grass per day respectively. The average quantity of dry matter consumed per Jersey per day was 27.5 pounds whereas that consumed by the Holstein was 30.4, the grass grazed by the latter having a higher percentage of dry matter than that grazed by the Jersey. He calculated that, with allowance for maintenance, the digestible nutrients consumed by these groups would support a production of 26 and 35 pounds of milk a day for the Jerseys and Holsteins respectively. In his grazing trials, the cows had access to the pasture both night and day.

Although the cows in our studies here reported were given a grain mixture at time of milking which would account for part of the nutrients required for maintenance and for the comparatively high milk production, an abundance of grass was yet necessary to satisfy those requirements. With comparatively short grazing periods between morning and noon milking, between noon and night milking, and no grazing between night and morning milking, the cows had to graze within the five-hour period prior to milking in order to get sufficient nutrients. In that respect, the cows milked twice daily had longer periods between milking and apparently were able to satisfy their nutrient requirements outside of the five-hour contamination period prior to milking.

Indications are that alfalfa-bromegrass is being pastured by dairy cows with success and will, therefore, continue to fit into the feeding program.

Dorrance and Rather (3) and Harrison, Wright and Taylor (6) reported very excellent economic results from pasturing Guernseys on alfalfa, but made no mention of the effect of the green alfalfa on the flavor of the milk. However, as the milking routine on the farm on which the studies were made was twice daily, the cows having access to the pasture during intervals between milking, no feed flavors might be expected as the cows would undoubtedly have taken their fill many hours prior to milking.

Summary and Conclusions

The so-called soda, alkaline flavor of milk was undoubtedly due to the alfalfa-bromegrass pasture, which was probably grazed more

heavily when the cows were first turned from the relatively mature Sudan to the succulent alfalfa-bromegrass, and to the short grazing periods between milkings when the cows were milked three times daily, which resulted in their grazing almost up to the time of milking. The intense off-flavor noted in the milk was of such a nature that there was no resemblance to a feed flavor.

The intensity of the off-flavor was less as pasturing progressed, but was yet objectionably persistent, the latter off-flavor resembling more closely the characteristic feed flavors.

Alfalfa contributed more to the off-flavor than did the bromegrass of the alfalfa-bromegrass pasture.

When cows were kept off the pasture seven hours prior to milking no feed flavors were noted in the milk.

Comparatively heavy lactating cows milked three times daily and pastured only two of the three periods between milking must graze within the harmful five-hour period prior to milking in order to obtain sufficient nutrients even when fed a grain mixture. Hence, special precaution must be exercised in pasturing cows milked three times per day on alfalfa-bromegrass pasture.

Cows milked two times daily and having free access to alfalfa-bromegrass pasture yielded milk free of off-flavors due to feed.

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MICHIGAN FARM BUSINESS SUMMARY—1938

State Summary, Annual Farm Business Report, 1,252 Michigan Farms—1938

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SECTION OF FARM MANAGEMENT

The extension project in farm accounting sponsored by the Farm Management Department of Michigan State College and the county agricultural agents was conducted in 76 counties in 1938. A total of 1,378 farm account books were summarized, which is the largest number of records closed for any single year since the project was started in 1929.

A farm business report has been prepared for each type-of-farming area in Michigan (Fig. 1) with the exception of Area 13. These reports were based on the farm records kept in the different areas. Only 1,252 records were used in the area reports. The remainder of the records (126) were not used, either because they were received too late or because they were non-comparable for one reason or another. Since some of the area boundaries have been revised and most of the area numbers have been changed for 1938, one should be careful to be certain that the areas are properly matched before making comparisons with the figures for previous years.

All records were carefully checked by representatives of the Farm Management Department before being summarized. Most of the checking was done in the presence of the farmer-cooperator. Each cooperator has received a copy of the appropriate area report with his own farm figures tabulated. The report makes possible a comparison of an individual farm with the average of other farms of similar type and size, as well as a comparison with the more and the less successful farms. A farmer is then able to determine the strong and weak points in his business and thus has a basis for making adjustments needed in order to increase the farm income.

Farm Earnings in 1938

Earnings on Michigan accounting farms were practically the same in 1938 as in 1937 and 1934. The 1938 earnings were lower than those for 1936 or 1935, but considerably above the average for the 10-year period, 1929-38.

The total cash receipts for 1938 averaged \$2,989, or \$369 less than for 1937 (Table 1). The decline in livestock and livestock product

*E. B. Hill, Kenneth Ousterhout, and L. H. Brown of the Farm Management Department and the county agricultural agents in 76 counties assisted with this project.

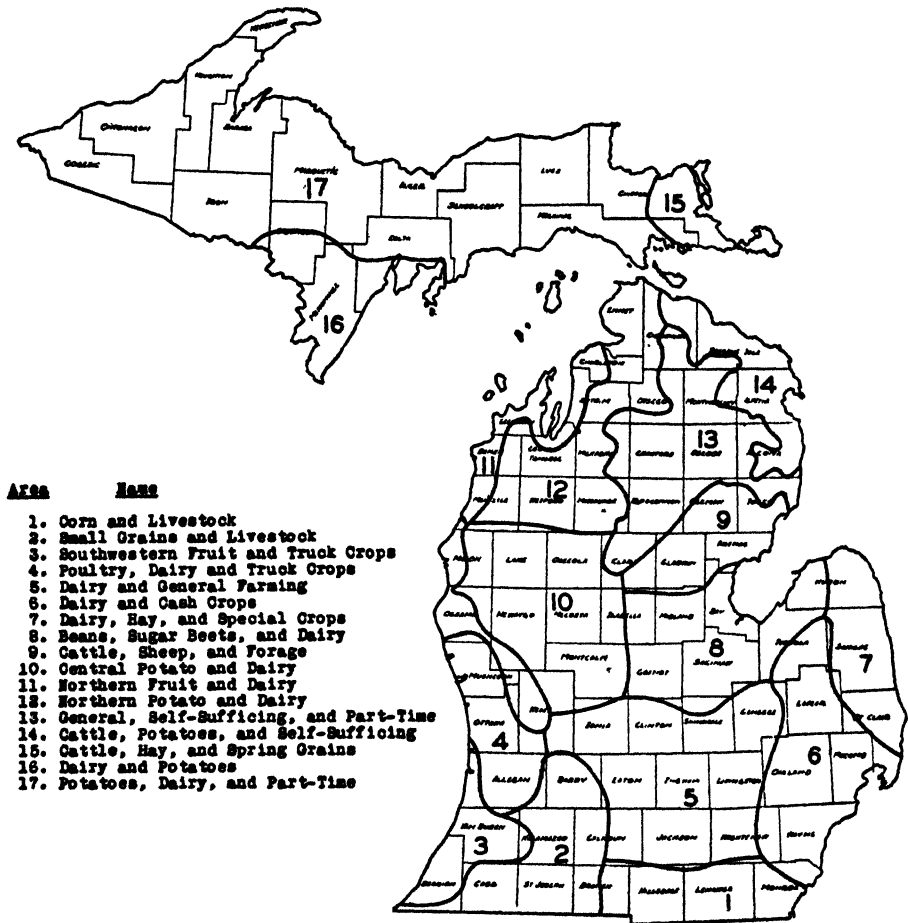


Fig. 1. Type of farming areas in Michigan.

prices and the drop in the prices of some crops accounted for most of this decline in cash receipts. From 1937 to 1938 there was a decline in the average price of dairy products, meat animals, chickens and eggs, grains, and some cash crops. Although livestock and livestock product prices dropped, the decline in feed prices was relatively greater, resulting in favorable feeding ratios for most kinds of livestock. Crop yields were better in 1938 than in 1937 for the state as a whole, but the drop in prices of some crops reduced the income from crop sales.

The total cash expenses for 1938 averaged \$1,841, or \$260 less than for 1937. Both cash expenses and cash receipts declined about the same percentage from a year earlier. An analysis of the \$260 decrease in cash expenses from 1937 shows that machinery decreased \$88, feed purchases \$69, improvements \$38, livestock purchases \$33, hired labor \$21, and crop expenses \$17. Taxes and miscellaneous expenses were each \$3 higher in 1938. The decrease in the various expense items was due partially to less cash being available for such purposes. In

Table 1. Ten-year comparison of financial returns on Michigan farms, 1929-38.

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	10-Year Average
Number of farms	427	771	925	831	795	845	933	1,065	1,163	1,352	900
Total acres	159	162	163	156	154	157	164	161	158	163	160
Tillable acres	107	111	109	103	98	103	107	108	104	108	106
Average investment	\$16,950	\$17,264	\$15,859	\$12,974*	\$11,813	\$12,192	\$12,510	\$12,502	\$12,904	\$13,074	\$13,802
Cash receipts	\$3,690	\$3,373	\$2,299	\$1,805	\$1,825	\$2,389	\$2,826	\$3,353	\$3,358	\$2,989	\$2,791
Cash expenses	2,351	2,128	1,487	1,068	1,000	1,324	1,668	1,869	2,101	1,841	1,686
Net cash income	1,339	1,245	812	717	825	1,065	1,158	1,481	1,257	1,148	1,105
Net change in inventory	354	-430	-520	-524	153	252	398	650	155	284	1,177
FARM FAMILY INCOME	1,693	815	292	193	978	1,317	1,556	2,134	1,412	1,432	1,183
Less: Unpaid family labor	259	215	175	139	138	142	166	191	186	210	182
NET FARM INCOME	1,434	600	117	54	840	1,175	1,390	1,943	1,214	1,222	999
Less: Operator's labor	671	667	546	423	420	418	432	538	528	528	517
Return for investment and management	763	-67	-429	-369	420	757	958	1,405	686	694	482
RATE EARNED ON INVESTMENT, per cent	4.49	-39	-2.70	-2.84	3.56	6.21	7.66	11.24	5.32	5.33	3.79
NET FARM INCOME	\$1,434	\$600	\$117	\$54	\$840	\$1,175	\$1,390	\$1,943	\$1,214	\$1,222	\$999
Less: Interest at 5%	849	863	793	649	591	610	626	625	645	651	690
LABOR INCOME	585	-263	-876	-595	249	565	764	1,318	569	571	309

*Land values were deflated approximately 25 per cent at the beginning of 1932.

addition, many farmers had spent considerable money on replacements of machinery and improvements during the previous two years. Feed prices were lower and crop yields were better, making feed purchases less. Hired labor expense declined largely because some fruit crops were smaller, thus requiring less harvest labor than in 1937. Fewer livestock were purchased and prices were lower, so livestock purchases also declined in 1938.

Deducting the cash expenses from the cash receipts leaves a net cash income of \$1,148, or \$109 less than in 1937. The net cash income is the actual amount of money remaining after cash operating expenses are paid. This amount is available for family living or to meet interest and principal payments on indebtedness.

To show what the farm actually made or lost for the year it is necessary to make some further calculations. The average total farm inventory increased \$284 between the beginning and the end of the year even though cash expenses were less in 1938 than in 1937. Improvement and machinery accounts showed inventory increases because farmers continued to spend more than enough to offset depreciation. The feed inventory showed an increase, owing to the good crop yields. The livestock account showed an increase largely because of the greater number of cattle on hand at the close of the year. The inventory increase is added to the net cash income to get the farm family income. A charge for unpaid family labor is then deducted, leaving the net farm income, from which either rate earned on investment or labor income is obtained (Table 1).

The 1,252 farms showed an average labor income of \$571 for 1938. This earning figure represents what the farm returned for the operator's labor and management after paying all cash operating expenses, allowing for depreciation and other inventory losses, charging for family labor other than the operator, and deducting 5 per cent interest on the investment. The labor income does not include the value of the farm-grown products used in the home. The range in labor incomes was from \$6,686 to minus \$2,959. The following discussion is relative to some of the more important livestock and crop enterprises that influenced earnings in 1938.

The decline in the prices of dairy products from 1937 to 1938 made the dairy situation less favorable in 1938. According to the Michigan Livestock Report, butterfat prices averaged 20 per cent lower than for the previous year. Wholesale milk prices averaged 13 per cent lower in 1938. However, the situation was not so unfavorable as that would indicate because feed was much cheaper and the index of all farm costs for the entire state declined from 122 in 1937 to 115 in 1938. Cattle prices also declined some but the purchasing power remained good. In general, there was not so much margin in cattle feeding in 1938 as in 1937. Hog prices received by Michigan farmers averaged 19 per cent lower than in 1937. However, the lower grain and feed prices during 1938 made for more favorable feeding ratios than in 1937. Egg prices declined 3 per cent and chicken prices were 2 per cent lower than in 1937. However, poultrymen made fairly good incomes because 1938 fall egg prices were good and grain prices were at a low for the year. The sheep enterprise was less favorable in 1938. Lamb prices declined 21 per cent and wool prices fell 50 per cent from 1937. On accounting farms the lambs raised per 100 ewes averaged 103 in 1937 but only 90

in 1938. Lamb feeders lost generally during the early part of 1938, while in the fall, conditions were somewhat more favorable.

The discussion here should not lead one to assume that favorable feeding ratios necessarily mean that farmers are making money. About three-fourths of the tillable acres on farms in this report are used in producing feed crops for livestock. If feed prices are low it means that the value of the feed crops produced per acre is low. What a favorable feeding ratio does mean is that the livestock offers a better market for the crops than if they had to be sold on a cash market.

The 1938 season was favorable for general crops. Good crop yields resulted in increased quantities of feed being available. Corn, wheat, oats, barley, and rye yields were all better in 1938 than in 1937. Hay yields were also as good as a year earlier. On the other hand, prices for those crops were lower than in 1937 which meant cheaper feed for 1938. Potatoes, the leading cash crop for the state, averaged a yield of 167 bushels an acre in 1938 on accounting farms as compared with 125 bushels in 1937. The price was also a little higher so that the income from potatoes was greater in 1938. Beans, the second most important cash crop in the state, averaged a better yield in 1938 but the average seasonal farm price was less than in 1937. In 1938, the sugar beet acreage increased 60 per cent over that of 1937. The 1938 yield averaged about one ton more per acre than for the year earlier. Growers received approximately \$8 per ton, including government payments, which made sugar beets one of the better cash crops on farms adapted to the crop in 1938. Wheat, as a cash crop, returned few farmers any profit in 1938. The acreage of alfalfa and clover cut for seed was much greater than a year earlier but yields were less and prices were less than half so high. The yields of most truck crops such as onions, cucumbers, peas, and tomatoes were good in 1938. Onion, cucumber, and market tomato prices were lower than in 1937 while prices of tomatoes for manufacture and pea prices were slightly higher. As compared with most other crops the situation for certain fruit and truck crops such as apples, peaches, cherries, and strawberries was entirely different. Severe spring freezes caused drastic reduction in production of those crops and the production was unequally distributed among growers. The smaller supplies resulted in farmers receiving better prices than in 1937 for apples, peaches, and strawberries while cherry prices were no higher, because of large supplies in other parts of the United States.

Variation in Farm Earnings

Farm earnings vary greatly. Figure 2 shows the distribution of labor incomes on the 1,252 accounting farms during 1938.

There was a large variation in the average of all farm earnings between the different areas within the state. There was even greater variation in earnings between different farms within the same area. The factors influencing earnings in each area of the state are discussed in a separate report prepared for that area.

Figure 3 provides a graphic comparison of the earnings of farm account cooperators for each year 1929-38 inclusive.

Farm earnings not only vary greatly on different farms for each year but also vary greatly on the average of all farms from year to year. The labor incomes, as indicated by about 9,000 individual farm

LABOR INCOME	PER CENT						No. FARMS	PER CENT
	5	10	15	20	25	30		
\$3001 or MORE							18	1.5
2501 to 3000							13	1.0
2001 2500							36	2.9
1501 2000							60	4.8
1001 1500							163	13.0
501 1000							303	24.2
1 500							407	32.5
-500 0							175	14.0
-1000 -501							53	4.2
-1001 & LESS							24	1.9

Fig. 2. Distribution of labor incomes on 1,252 Michigan farms, 1938.

records kept during the last 10-year period, 1929-38, are shown in Table 1. The average labor income per farm in 1929 was \$585. Then followed the disastrous years of 1930-32 when labor incomes averaged "in the red" more than \$500 per farm for the three-year period. Prices started to improve in 1933 and labor incomes for that year amounted



Fig. 3. Percentage distribution of labor incomes on Michigan farms for 10 years, 1929-38.

to \$249 per farm. This improvement continued and labor incomes mounted until in the peak year, 1936, they averaged \$1,318 per farm. For 1937 and 1938, labor incomes averaged \$569 and \$571 respectively, which represents about the same earning figures as for the years 1929 and 1934.

What causes this year-to-year variation in farm earnings? Changes in farm organization and management and variations in crop yields and animal production are important factors on individual farms. However, a fluctuating general price level is probably the most important factor causing year-to-year variations in farm earnings on groups of farms. When the general price level changes, the prices of basic commodities, such as wheat, corn, pork, butter, and wool change quickly.

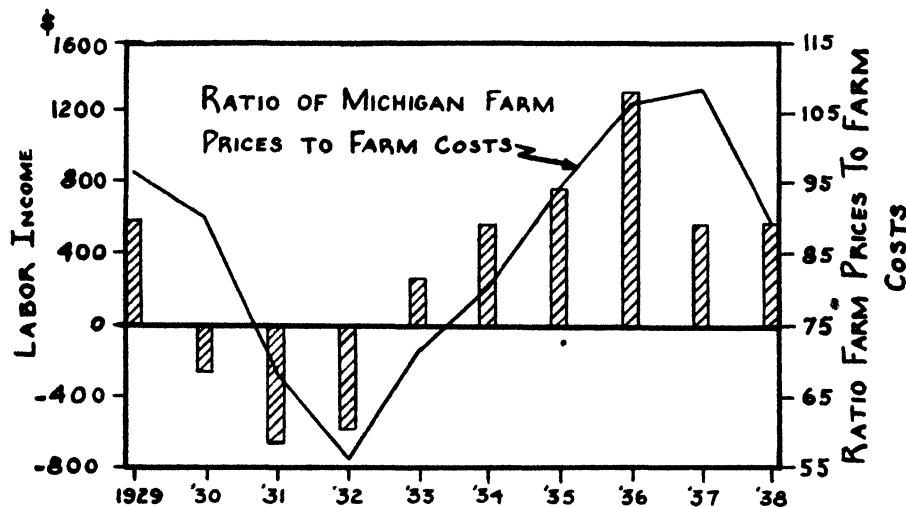


Fig. 4. Relationship between the ratio of Michigan farm prices to farm costs, and labor incomes, 1929-38.

Wages, taxes, debts, retail prices, and overhead costs change very slowly. Therefore, farmers are benefited by rising prices but are adversely affected by falling prices. This is shown by comparing two indexes prepared by the Economics Department of Michigan State College, one entitled "Prices Received by Farmers" and the other "Farm Costs". The ratio of farm prices to farm costs for Michigan farmers in 1929 was 96. This ratio fell to a low of 56 in 1932 and stood at 89 in 1938. The relationship that exists between this price ratio and labor income is shown in Fig. 4. There is not a perfect correlation between the two series because labor incomes are not dependent on this price ratio alone but also on crop yields and other factors.

State and Area Averages

The accompanying tables 2, 3, 4 and 5 indicate that farm earnings in any one year vary considerably between different areas. The different areas do not retain the same relative position each year, due to weather and price changes, both of which are beyond a farmers control.

Table 2. Averages, investments, and financial summary on 1,252 Michigan farms by type-of-farming areas, 1938.

Type-of-Farming Areas.....	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of Farms	1,252	90	120	52	67	191	67	30	112	56	99	66	146	46	18	32	60
Total acres	163	189	195	89	114	179	163	176	133	164	187	126	171	159	192	150	153
Per cent of land owned	79	68	68	86	82	72	72	91	76	72	83	94	89	89	79	96	94
Per cent of farm area tillable	66	75	74	83	78	73	74	83	76	54	58	65	56	53	66	41	37
Tillable acres	108	142	145	74	89	130	120	148	102	89	108	82	95	83	127	62	56
Capital Investments, Total	\$13,024	\$17,564	\$15,401	\$16,101	\$11,032	\$15,594	\$16,459	\$15,279	\$15,334	\$8,982	\$10,979	\$14,492	\$8,056	\$7,318	\$11,058	\$9,404	\$8,082
Real estate (less house)	9,062	11,698	10,889	13,007	7,490	10,634	11,774	9,733	10,730	5,931	7,521	11,410	5,294	4,564	7,518	6,209	6,510
Machinery and equipment	1,407	1,808	1,379	1,660	1,116	1,555	1,596	1,834	1,657	1,001	1,188	1,560	1,067	1,023	1,483	1,546	1,190
Feed, crops and supplies	827	1,228	1,126	1,126	806	1,098	973	1,230	1,222	486	620	692	506	394	403	328	282
Livestock (includes horses)	1,728	2,830	2,007	915	1,620	2,257	2,116	2,432	1,725	1,564	1,650	830	1,189	1,227	1,654	1,331	1,081
Cash Receipts, Total	\$2,989	\$4,536	\$3,230	\$3,753	\$2,854	\$3,397	\$3,244	\$3,923	\$3,212	\$1,932	\$2,648	\$3,550	\$2,159	\$1,546	\$3,021	\$2,256	\$1,641
Livestock sales, total	1,969	3,559	2,334	979	2,300	2,517	2,470	2,858	1,861	1,301	1,801	936	1,339	945	2,527	1,584	1,096
Crop sales	727	619	587	2,440	326	560	536	682	1,031	394	1,595	2,317	1,558	356	2,914	378	293
Labor of farm	117	107	124	108	84	107	70	125	119	145	96	143	110	135	175	152	185
Other receipts	176	251	185	231	144	213	148	238	202	92	150	154	152	110	75	142	157
Cash Expenses, Total	\$1,841	\$3,189	\$2,118	\$2,611	\$1,806	\$2,146	\$1,888	\$2,078	\$1,819	\$1,146	\$1,488	\$2,108	\$1,238	\$890	\$1,422	\$1,219	\$1,075
Farm improvements	198	293	300	600	144	226	190	238	127	135	175	131	132	123	103	171	101
Machinery and equipment	536	741	560	600	462	596	506	715	648	344	467	559	461	379	368	371	461
Livestock purchases	288	812	306	154	275	433	277	409	256	314	211	120	135	82	191	119	86
Feed bought	244	501	320	228	424	294	221	181	158	91	208	165	148	77	272	214	221
Hired labor	238	385	249	497	211	229	292	167	209	83	174	612	163	101	209	166	165
Crop expense	201	247	209	578	153	215	238	219	219	88	140	381	121	74	149	112	89
Taxes	74	114	103	93	68	81	94	82	76	55	70	68	48	36	40	40	28
Other expenses	62	96	71	156	69	72	80	64	56	31	43	72	30	18	50	60	33
Net Change in Inventory	\$284	\$411	\$290	\$375	\$271	\$311	\$282	\$209	\$400	\$337	\$269	\$-13	\$279	\$321	\$101	\$162	\$204
Improvements	68	99	135	341	20	37	32	93	58	39	54	97	35	35	-6	54	10
Machinery and equipment	86	149	86	50	97	112	37	102	143	54	78	38	84	73	-71	-20	95
Feed, crops, and supplies	82	222	21	-37	41	113	101	21	109	30	117	-174	126	163	115	62	114
Livestock (includes horses)	48	-56	48	21	113	49	112	-7	109	175	33	26	24	43	66	66	-15
Net Cash Income	\$1,148	\$1,347	\$1,112	\$1,147	\$1,048	\$1,251	\$1,356	\$1,815	\$1,363	\$786	\$1,160	\$1,412	\$921	\$656	\$1,589	\$1,037	\$566
Plus: Inventory increase	284	411	290	375	271	311	282	209	400	307	269	13	279	321	101	162	204
Farm Family Income	1,432	1,758	1,402	1,522	1,319	1,562	1,638	2,034	1,763	1,093	1,429	1,429	1,200	977	1,700	1,199	770
Less: Unpaid family labor	210	183	205	268	157	194	242	253	192	213	256	178	186	181	196	230	321
Net Farm Income	1,222	1,565	1,197	1,254	1,162	1,368	1,396	1,780	1,571	880	1,173	1,251	1,014	796	1,504	973	449
Less: Operator's labor	528	573	576	521	582	576	569	587	563	549	514	468	438	463	402	473	445
Rate earned on investment	5.33%	5.65%	4.08%	4.55%	5.26%	5.08%	5.02%	7.94%	6.57%	4.86%	6.01%	5.47%	6.91%	4.56%	9.42%	5.38%	.09%
Net Farm Income	\$1,222	\$1,254	\$1,197	\$1,254	\$1,162	\$1,368	\$1,396	\$1,799	\$1,571	\$880	\$1,173	\$1,251	\$1,014	\$796	\$1,504	\$979	\$449
Less: Interest at 5%	651	878	770	865	552	780	823	764	707	449	573	724	403	366	553	470	404
Labor Income—1938	571	637	427	419	610	583	573	1,035	804	431	623	537	611	430	951	509	45

Table 3. Percentage of land in different crops and crop yields by type-of-farming areas, 1938.

Type-of-Farming Areas . . .	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,252	90	120	52	67	191	67	30	112	56	99	66	146	46	18	32	60
Number tillable acres	108	142	145	74	89	130	120	148	102	89	108	82	95	85	127	62	56
Per cent tillable acres in hay, seed and pasture	45	37	41	24	42	42	46	48	32	58	52	34	54	61	65	57	69
Per cent tillable acres in legumes*	31	26	29	26	31	29	32	23	27	39	35	38	31	43	28	41	30
Per cent tillable acres in																	
Tillable pasture	17	14	16	8	14	18	21	23	11	21	21	11	21	19	18	13	11
Alfalfa hay	15	12	13	8	13	13	15	12	14	24	18	15	20	26	6	23	11
Other hay	12	10	18	8	14	9	10	12	5	12	12	8	13	13	40	20	47
Corn	16	26	11	21	18	18	18	9	15	14	13	10	14	10	0	11	2
Wheat	9	13	13	5	11	13	9	10	10	3	5	2	3	4	4	1	1
Oats (oats and barley mixed)	10	11	7	3	13	12	13	12	10	11	9	7	9	9	15	11	10
Barley	2	3	1	0	2	3	3	6	7	2	1	1	1	3	6	9	6
Beans	3	0	1	0	1	4	1	6	14	4	2	1	1	1	0	0	0
Sugar beets	1	1	0	0	1	1	1	4	8	1	0	0	0	0	0	1	4
Potatoes	2	1	1	1	9	1	3	0	1	2	5	2	6	5	1	6	4
Fruit and truck	4	2	1	43	2	1	3	0	1	1	2	39	2	1	0	1	1
Other crops	9	7	17	10	7	8	3	6	4	5	12	4	10	9	10	4	7
Crop Yields per Acre:																	
Alfalfa hay T.	17	20	17	18	19	20	16	17	18	14	17	15	13	16	12	22	20
Other hay T.	14	19	16	15	17	16	16	14	14	14	13	12	9	13	13	17	14
Corn for silage T.	80	96	89	73	76	87	83	78	91	62	77	88	62	62	...	79	67
Corn (shelled) Bu.	39	47	38	32	38	40	39	33	39	30	37	29	26	26	...	35	...
Wheat Bu.	23	21	21	21	19	26	27	27	31	21	20	20	14	22	17	17	11
Oats Bu.	37	38	31	28	38	40	41	41	52	34	38	36	28	27	28	34	25
Barley Bu.	29	24	24	20	20	31	30	30	38	26	26	26	16	19	15	30	24
Beans Bu.	18	20	14	...	15	18	17	21	21	15	16	12	9	12	...	...	...
Sugar beets T.	93	98	...	...	96	73	73	78	96	90	174	164	...	176	...	92	...
Potatoes Bu.	167	136	141	110	116	126	146	115	130	145	174	164	191	176	100	193	206
Value crops produced per tillable acre	\$11 14	\$14 87	\$11 85	...	\$14 65	\$13 71	\$13 96	\$12 84	\$19 12	\$11 55	\$14 58	...	\$14 22	\$12 38	\$9 59	\$19 68	\$14 58
Crop sales	727	619	587	\$2 440	326	560	556	682	1,030	301	598	\$2,317	558	356	244	378	203
Feed bought	244	501	320	228	424	294	221	184	158	91	208	165	148	77	272	214	231

*Tillable land in tree fruits and vineyard is not included in this factor

Table 4. Livestock, kinds, amounts, and returns by type-of-farming areas, 1938.

Type of Farming Areas	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
All Farms																
Number of farms	1,252	90	120	52	67	191	67	30	112	56	99	146	46	18	32	60
Livestock Income, Total	\$1,742	\$2,709	\$2,090	\$869	\$2,138	\$2,334	\$2,450	\$1,723	\$1,245	\$1,644	\$883	\$1,239	\$906	\$2,370	\$1,561	\$1,020
Livestock income per tillable acre	16.58	19.05	14.49	18.57	16.47	19.39	16.60	16.90	14.00	15.30	16.48	13.14	10.71	18.60	25.06	18.27
Productive animal units	21.2	32.6	25.7	8.7	19.9	27.6	27.6	20.2	21.3	20.7	10.8	16.1	17.0	18.7	16.8	14.5
Tillable acres per productive animal unit*	5.0	4.4	5.6	5.4	4.5	5.3	5.4	5.0	4.2	5.2	4.9	5.9	5.0	6.8	3.7	3.9
Cattle:																
Number of dairy cows	9.4	10.4	9.6	4.6	10.5	12.6	14.9	8.6	7.8	10.2	6.0	8.9	8.8	11.0	11.9	9.6
Dairy sales per cow	\$93	\$100	\$104	\$103	\$112	\$94	\$94	\$87	\$56	\$84	\$74	\$86	\$52	\$147	\$104	\$75
Dairy sales, total	882	1,043	995	476	1,171	1,530	1,364	746	448	861	445	770	459	1,617	1,239	720
Cattle income, total	1,199	1,505	1,315	638	1,491	1,946	2,103	1,080	824	1,206	608	990	693	1,863	1,446	854
Poultry:																
Number of hens	84	126	79	57	169	105	97	107	58	89	59	46	43	100	36	52
Egg production per hen	153	151	137	154	151	159	160	155	136	158	141	141	143	165	164	154
Egg sales per hen	\$2.26	\$2.39	\$1.97	\$2.23	\$2.63	\$2.49	\$2.32	\$2.21	\$1.72	\$2.24	\$2.17	\$1.67	\$1.48	\$3.11	\$2.36	\$2.55
Egg sales, total	191	299	155	127	443	250	225	236	99	199	128	76	63	311	82	131
Poultry income, total	245	394	200	158	540	333	272	297	145	241	106	114	85	392	94	145
Sheep:																
Number of ewes	10	16	14	0	2	6	5	7	19	8	1	3	8	4	0	0
Lambs raised per 100 ewes	90	80	86	.....	113	97	116	106	97	101	109	91	109	110	.....	104
Sheep income, total	\$70	\$127	\$72	0	\$10	\$54	\$47	\$58	\$129	\$59	\$8	\$18	\$53	\$43	0	\$3
Hogs:																
Number of sows	1.2	2.9	2.7	5	7	14	1	14	8	7	4	8	7	4	2	4
Number litters farrowed	2.0	5.1	4.6	9	1.0	2.6	1.1	2.5	1.3	1.1	6	1.3	1.0	9	2	6
Pigs weaned per litter	6.9	6.5	6.6	6.7	7.0	6.9	7.4	7.0	7.3	7.1	8.1	7.5	8.0	8.4	7.2	7.0
Hog income, total	\$357	\$677	\$501	\$73	\$111	\$114	\$28	\$288	\$146	\$137	\$78	\$116	\$75	\$68	\$21	\$18

Table 5. Labor, machinery, and improvement costs by type-of-farming areas, 1938.

Type-of-Farming Areas.....	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms.....	1,252	90	120	52	67	191	67	30	112	56	99	66	146	46	18	32	60
Man Labor:																	
Number of men.....	1 9	2 1	2 0	2 4	1 7	1 8	2 1	2 0	1 8	1 7	1 9	2 3	1 8	1 7	1 9	1 8	1 9
Man labor cost, total.....	\$976	\$1,152	\$1,030	\$1,286	\$850	\$999	\$1,103	\$1,009	\$964	\$750	\$944	\$1,258	\$907	\$745	\$867	\$819	\$821
Hired labor.....	238	385	249	497	211	229	292	167	209	88	174	612	186	101	209	126	55
Charge for family help.....	210	193	205	268	157	194	242	253	192	213	256	178	186	181	196	220	321
Charge for operator's labor.....	528	574	576	521	582	576	569	587	563	449	514	468	458	463	462	473	445
Man labor cost per tillable acre.....	9 04	8 10	7 11	17 37	10 67	7 70	9 16	6 84	9 45	8 44	8 75	15 35	8 49	8 79	6 81	13 15	14 70
Power and Machinery:																	
Machinery cost: Total.....	\$317	\$398	\$323	\$388	\$252	\$327	\$364	\$385	\$349	\$219	\$275	\$420	\$260	\$222	\$395	\$321	\$341
Per tillable acre.....	2 93	2 80	2 23	5 24	2 83	2 52	3 02	2 61	3 42	2 47	2 55	5 13	2 74	2 63	3 10	5 16	4 31
Per cent farms using tractors.....	61	78	61	60	49	70	73	67	79	34	46	70	44	43	61	62	70
Number of horses.....	2 7	3 0	3 3	2 2	2 8	3 0	3 0	3 1	2 6	2 7	2 8	1 8	2 3	2 5	2 5	1 9	1 5
Improvements:																	
Net annual cost: Total.....	\$138	\$187	\$169	\$136	\$196	\$175	\$161	\$139	\$152	\$93	\$125	\$104	\$89	\$78	\$108	\$106	\$87
Per tillable acre.....	1 26	1 52	1 16	1 84	1 41	1 35	1 34	94	1 49	1 04	1 15	1 27	94	82	84	1 69	1 56
Investment per animal unit.....	142	155	162	274	138	144	177	120	199	93	133	212	116	102	132	136	141
Feed bought per tillable acre.....	\$2 26	\$3 52	\$2 21	\$3 08	\$4 77	\$2 26	\$1 84	\$1 25	\$1 55	\$1 02	\$1 92	\$2 01	\$1 56	\$0 91	\$2 13	\$3 44	\$4 13
Crop expenses per tillable acre.....	1 86	1 74	1 44	7 81	1 72	1 66	1 89	1 49	2 15	99	1 29	4 65	1 28	.88	1 17	1 50	1 42
Taxes per tillable acre.....	.60	.80	.71	1 26	.77	.62	.78	.55	.75	.62	.65	.82	.50	.42	.47	.74	.51
Other expenses per tillable acre.....	.64	.82	.59	1 14	.91	.59	.89	.48	.63	.37	.61	.73	.48	.28	.40	1 44	1 06
Gross income per tillable acre.....	\$25 10	\$26 07	\$19 73	\$47 64	\$29 59	\$22 80	\$25 80	\$22 37	\$29 32	\$19 80	\$23 02	\$39 51	\$21 85	\$18 77	\$23 10	\$35 55	\$27 76
Total expenses per tillable acre.....	18 67	19 10	15 45	37 74	23 08	16 70	18 92	14 16	19 44	14 95	16 92	29 96	15 99	14 83	14 92	27 42	27 69
Net income per tillable acre.....	6 43	6 97	4 28	9 90	6 51	6 10	6 88	8 21	9 88	4 85	6 10	9 55	5 86	3 94	8 18	8 13	.07
Expenses per \$100 Income.....	74	73	78	79	80	73	73	63	66	76	74	76	73	79	65	77	100

in the price level for the products produced, and changes in the costs of items that enter into the production of various products, may cause changes in the relative position.

FOREST TREES AND SHRUBS OF MICHIGAN FOR BEE PASTURAGE

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Bees obtain nectar and pollen from a large number of forest trees and shrubs. Yet the value of trees for this purpose is not generally recognized. A knowledge of the plant species which are of value for bee pasturage and the ways in which these species could be managed for honey production is essential information for the apiarist and the forest manager who wish to improve conditions for bees.

Not all trees and shrubs are of value for bee culture, mainly because they do not secrete sufficient nectar, or because the nectar, if produced, may be unavailable to the bees. The accompanying table gives some trees and shrubs of Michigan in relation to their value for bee pasturage. The list of 65 species does not include all of those growing in Michigan which are utilized by bees for nectar and pollen. Particular emphasis is given to the species which are important in the native forests or which are planted in connection with reforestation programs. Little emphasis is given to shrubs used exclusively for ornamental purposes. Information concerning the value of the species was obtained from published sources listed under "literature cited," supplemented by field observation during the three-year period, 1937-1939.

Management of Existing Stands for Honey Production

Much can be done to increase the value of existing forest lands for bees. Particular effort should be made to preserve in the stands those species which are of high value for bee culture. Basswood and other trees especially valuable for bee pasturage, should be retained. In some localities basswood honey is no longer produced because this tree has been almost completely eliminated by cutting. The use of selective cutting and the avoidance of clear cutting methods will be effective in keeping stands productive for bee pasturage.

Improvement cuttings and thinnings should be made in immature stands to assist the survival and growth of the better species. Since the abundance of blossoms will depend upon tree dominance and amount of foliage, trees should be given sufficient growing space. Trees with plenty of room flower much earlier than when crowded. Open growth trees, in fact, are best for early and abundant flowering.

*Harmon Cantrell assisted in compiling some of the records.

Some Trees and Shrubs of Michigan in Relation to Their Value for Bee Pasturage.

Scientific Name	Common Name	Type of Pasturage	Approximate Date of Blooming	Relative Value	Range in Michigan	Remarks	References
1. <i>Acer negundo</i>	Box Elder	Nectar & Pollen	April & May	Slight Importance	Southern Michigan	Dioecious	2, 3
2. <i>Acer platanoides</i>	Norway Maple	Nectar	June	Slight Importance	State Wide	Introduced—A common ornamental	3
3. <i>Acer rubrum</i>	Red Maple	Nectar	April & May	Slight Importance	State Wide	Good for early use; flowers too early for use in some years	2, 3
4. <i>Acer saccharinum</i>	Silver Maple	Nectar	April & May	Slight Importance	Southern Michigan	Good for early use; flowers too early for use in some years	3
5. <i>Acer saccharum</i>	Sugar Maple	Nectar & Pollen	May & June	Important	State Wide	Very important for early use by bees	2, 3
6. <i>Alnus incana</i>	Speckled Alder	Pollen	May	Slight Importance	Northern Michigan	A swamp species	2, 3
7. <i>Amelanchier</i> spp.	Service Berry	Nectar & Pollen	April & May	Slight Importance	State Wide	A shrub or small tree	2, 3
8. <i>Betula</i> spp.	Birch	Pollen	April & May	Slight Importance	Northern Michigan	Common on cut over lands in Northern Michigan	2, 3
9. <i>Carpinus caroliniana</i>	American Hornbeam	Pollen	April	Slight Importance	State Wide	Small trees usually under-story in hardwood stands	2, 3
10. <i>Caragana aborescens</i>	Pea Tree	Pollen	May	Slight Importance	Introduced State Wide	Shrub or small tree used by bumble bees	3
11. <i>Castanea dentata</i>	Chestnut	Pollen	June	Slight Importance	Southern Michigan	Practically wiped out by chestnut blight	2
12. <i>Catalpa</i> spp.	Catalpa	Nectar	June	Slight Importance	Introduced S. Michigan	Nectariferous on leaves and flowers	2, 3
13. <i>Ceanothus americanus</i>	New Jersey Tea	Nectar	July	Slight Importance	State Wide	Native shrub, occasional in open woods	2, 3
14. <i>Cephalanthus occidentalis</i>	Button Bush	Nectar	July	Important	Southern Michigan	A swamp species	3
15. <i>Celastrus scandens</i>	Bittersweet	Nectar	June	Slight Importance	Southern Michigan	Woody vine, ornamental fruit	2
16. <i>Celtis occidentalis</i>	Hackberry	Pollen	May	Slight Importance	Southern Michigan	Occasional in Southern Michigan	3
17. <i>Cercis canadensis</i>	Redbud	Nectar & Pollen	May	Slight Importance	Southern Michigan	A shrub or small tree, ornamental	2
18. <i>Corylus americana</i>	Hazelnut	Pollen	May & June	Slight Importance	State Wide	Widely distributed shrub	3
19. <i>Cornus</i> spp.	Dogwood	Nectar & Pollen	Spring	Slight Importance	State Wide	Usually shrubby	3
20. <i>Crasilegus</i> sp.	Hawthorne	Nectar & Pollen	Spring	Slight Importance	State Wide	Small thorny tree, common in pastures	3
21. <i>Diervilla lonicera</i>	Bush Honeysuckle	Nectar	July & August	Important	State Wide	Bush, common on roadsides or burned over lands	2
22. <i>Elaeagnus angustifolia</i>	Russian Olive	Nectar	May & June	Important	Introduced State Wide	Ornamental, drought resistant	2
23. <i>Eryonymus altopurpureus</i>	Burning Bush	Nectar	June	Slight Importance	Southern Michigan	Shrub	2, 3
24. <i>Fraxinus</i> spp.	Ash	Pollen	Spring	Slight Importance	State Wide	Usually dioecious	2, 3
25. <i>Gaylussacia</i> spp.	Huckleberry	Nectar	May & June	Slight Importance	Southern Michigan	Fruit is huckleberry	2, 3
26. <i>Gleditsia triacanthos</i>	Honey Locust	Nectar	May & June	Important	Introduced S. Michigan	Often armed with stout thorns	2, 3
27. <i>Gnomocephalus dioica</i>	Kentucky Coffee Tree	Nectar	May	Slight Importance	Introduced S. Michigan	Often utilized by humming birds	3
28. <i>Hamamelis virginiana</i>	Witch Hazel	Nectar	Fall	Slight Importance	Southern Michigan	Late flowering, aids in strengthening colonies	2
29. <i>Hicoria</i> spp.	Hickory	Pollen	May	Slight Importance	Southern Michigan	Grows on well drained sites	2
30. <i>Ilex verticillata</i>	Michigan Holly	Nectar	May & June	Slight Importance	State Wide	Occasional in swamps	2
31. <i>Juglans nigra</i>	Black Walnut	Pollen	May	Slight Importance	State Wide	Widely planted for timber and nuts	2, 3
32. <i>Liriodendron tulipifera</i>	Yellow Poplar	Nectar	May & June	Slight Importance	State Wide	Valuable for building up bee colonies	3, 4
33. <i>Malus</i> spp.	Apple	Nectar	May	Important	State Wide	Bees used to pollinate orchards	2, 3
34. <i>Platanus occidentalis</i>	Sycamore	Pollen	May	Slight Importance	Southern Michigan	Found along stream borders	2
35. <i>Populus</i> spp.	Aspen & Cottonwood	Pollen	April	Slight Importance	State Wide	Dioecious, early source of pollen	2, 3

Some Trees and Shrubs of Michigan in Relation to Their Value for Bee Pasturage—Continued.

Scientific Name	Common Name	Types of Pasturage	Approximate Date of Blooming	Relative Value	Range in Michigan	Remarks	References
36. <i>Physocarpus opulifolius</i> ...	Nine Bark	Nectar	May & June...	Slight Importance	Southern Michigan...	Shrub	3
37. <i>Prunus americana</i> ...	American Plum	Nectar	May	Slight Importance	State Wide	Cross pollination by bees necessary.	2
38. <i>Prunus pennsylvanica</i> ...	Pin Cherry	Nectar	May	Important	State Wide	Common tree on cut-over forest lands.	2, 3
39. <i>Prunus serotina</i> ...	Black Cherry	Nectar	May	Important	State Wide	Honey has a bitter taste, strong flavor.	2, 3
40. <i>Prunus virginiana</i> ...	Choke Cherry	Nectar	May	Important	State Wide	Honey has a bitter taste, strong flavor.	2, 3
41. <i>Ptelea trifoliata</i> ...	Hop Tree	Nectar & Pollen	June	Slight Importance	State Wide	Production of nectar is variable.	1
42. <i>Pyrus spp.</i> ...	Pear	Nectar & Pollen	April & May	Important	State Wide	Cross pollination necessary for fruit production.	2, 3
43. <i>Quercus spp.</i> ...	Oak	Pollen	May	Slight Importance	State Wide	Native tree, abundant.	2, 3
44. <i>Rhus toxicodendron</i> ...	Poison Ivy	Nectar	May & June...	Slight Importance	State Wide	Plant but not honey is toxic to humans.	2, 3
45. <i>Rhus typhina</i> ...	Staghorn Sumac	Nectar	June	Important	State Wide	A shrub, common along fence rows and road sides.	2, 3
46. <i>Rhus glabra</i> ...	Smooth Sumac	Nectar	June	Important	State Wide	A shrub, common along fence rows and roadsides.	2, 3
47. <i>Ribes spp.</i> ...	Current & Gooseberry	Pollen & Nectar	May & June	Slight Importance	State Wide	Alternate host of white pine blister rust.	2, 3
48. <i>Robinia pseudoacacia</i> ...	Black Locust	Pollen & Nectar	May & June...	Important	Introduced S. Michigan	Used by honey bees, but mainly by bumble bees.	2, 3
49. <i>Rosa spp.</i> ...	Rose	Pollen	May & June...	Slight Importance	State Wide	Used considerably for pollen.	2, 3
50. <i>Rubus alleghoniensis</i> ...	Blackberry	Nectar	May	Important	Southern Michigan...	Common on burned over land.	2, 3
51. <i>Rubus idaeus</i> ...	Wild Red Raspberry	Nectar	June	Very Important	State Wide	Abundant on cutover land.	1, 2, 3
52. <i>Rubus canadensis</i> ...	Common Elder	Pollen	June	Slight Importance	State Wide	Common roadside shrub.	2, 3
53. <i>Salix spp.</i> ...	Willow	Nectar & Pollen	April & May	Important	State Wide	Diocious, common tree or shrub.	2, 3
54. <i>Sambucus racemiflora</i> ...	Sambucus	Nectar	May	Slight Importance	Southern Michigan...	Found along fence rows and on abandoned fields.	2, 3
55. <i>Symphoricarpos racemosa</i> ...	Snowberry	Nectar	June & July...	Slight Importance	State Wide	A shrubby species, occasional on open lands or woods borders.	2
56. <i>Spirea vulgaris</i> ...	Lilac	Nectar & Pollen	May & June...	Slight Importance	Introduced State Wide	Common ornamental shrub.	3
57. <i>Tilia glabra</i> ...	Basswood	Nectar	June & July	Very Important	State Wide	Most important native tree for honey.	2
58. <i>Tilia cordata</i> ...	Small Leaved Linden	Nectar	June & July	Important	Introduced	Recommended for ornamental plantings and honey.	1, 2, 3, 4
59. <i>Tilia platyphyllos</i> ...	Large Leaved Linden	Nectar	May & June...	Important	Introduced	Recommended for ornamental plantings and honey.	2
60. <i>Tilia vulgaris</i> ...	Common Linden	Nectar	June & July...	Important	Introduced	Recommended for ornamental plantings and honey.	2
61. <i>Toxylon pomiferum</i> ...	Osage Orange	Pollen	June & July...	Slight Importance	Introduced S. Michigan	Planted for hedge rows.	3
62. <i>Ulmus spp.</i> ...	Elm	Pollen	April & May	Slight Importance	State Wide	Common Michigan tree.	2, 3
63. <i>Vaccinium spp.</i> ...	Blueberry	Nectar & Pollen	June & July...	Slight Importance	N. Michigan	Fruit is common blueberry.	3
64. <i>Vitis spp.</i> ...	Grape	Nectar & Pollen	Spring	Slight Importance	State Wide	Common vine along fence rows.	3
65. <i>Zanthoxylum americanum</i> ...	Prickly Ash	Nectar	May & June...	Slight Importance	Southern Michigan...	Common shrub in hardwood stands.	3

Planting Trees and Shrubs for Honey Production

The value of trees for bee pasturage may well be considered in reforestation programs. The selection of tree and shrub species for roadside, field border, game food and cover, windbreak or yard plantings offer especially good opportunities since many species are valuable for these purposes as well as for bees.

Species which are not native locally must be established by planting. Trees such as the European linden and Russian olive could be used to advantage throughout most of the state. Hardy forms of sourwood (*Oxydendrum arboreum*) might be introduced successfully in southern Michigan. This tree species is native to the Appalachian mountain region of eastern United States. It ranges as far north as Pennsylvania and is perhaps the best tree species in the East for honey production.

The time and length of period of nectar secretions is important. Maples and willows, for example, are often important because they provide an early source of pollen or nectar. This makes it possible to strengthen the bee colonies early in the season, preparing them for effective work upon other plant species which blossom later. An analysis of local pollen and nectar sources may show a shortage occurring at a given period of the year. By selecting species which blossom at this time, planting may assist in bringing about a better coordinated program of honey production.

Best results in planting will be obtained by wide spacings to allow rapid development and early, abundant flowering.

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PRODUCTION AND MARKETING OF MICHIGAN'S FIELD PEAS

B. R. CHURCHILL
SECTION OF FARM CROPS

What has happened to Michigan's field pea crop? According to the federal agricultural census, the crop has decreased 90 per cent since 1910. For a crop that once ranked so high, that is a remarkable achievement in reverse. Several factors have been responsible for this radical change although the only ones emphasized in the past have been the pea aphid weevil and moth, insect pests that have ruined many field pea crops. While these pests were a major factor in the decline of the crop, recent investigations show that these insect pests were not the sole contributing factor.

In order to get a clearer picture of the problem, the distribution of the crop as reported by the federal agricultural census of 1910, 1920, 1930, and 1935, is shown in Table 1. Twenty-one counties each produced more than 20,000 bushels of field peas according to the 1910 report. By 1920 only 7 counties had a production of 20,000 bushels or more. Five were in this class in 1930 and only one in 1935. Thus a crop whose distribution once covered the northern half of the lower peninsula and the eastern half of the upper peninsula, 25 years later was confined largely to Chippewa County. Huron County once produced

**Table 1. Production of field peas (bushels) in leading counties*
of Michigan in 1910, 1920, 1930, 1935.**

County	1910	1920	1930	1935
Alcona.....	41,425	25,465	20,917	3,525
Alpena.....	40,704	32,939	34,959	8,278
Arenac.....	28,877	10,764	4,264	1,760
Charlevoix.....	23,358	1,980	3,997	225
Cheboygan.....	27,024	9,776	7,641	1,166
Chippewa.....	90,447	23,991	56,877	86,223
Clare.....	25,308	8,901	2,115	202
Delta.....	40,773	17,379	4,330	2,825
Emmet.....	30,146	2,426	1,763	280
Gladwin.....	48,900	29,855	3,723	2,170
Grand Traverse.....	21,362	440	714	330
Huron.....	161,941	71,727	19,141	3,760
Iosco.....	27,082	6,552	3,030	864
Mackinac.....	51,753	5,678	8,055	8,396
Menominee.....	29,045	16,240	3,313	1,556
Missaukee.....	27,863	2,853	2,619	402
Ogemaw.....	58,844	23,474	11,361	4,861
Osceola.....	36,127	5,120	249	42
Presque Isle.....	22,171	16,155	22,545	1,559
Sanilac.....	56,642	25,089	32,138	10,102
Schoolcraft.....	35,335	2,504	1,146	269

*Includes all counties that produced more than 20,000 bushels in any one of the four years listed.

more field peas than were produced by the entire state in 1934. Chippewa, the only county showing an appreciable increase since 1920, produced 54 per cent of the state's crop in 1934.

Previous to 1932, the total annual production for the leading states was between 2 and 3 million bushels. Since 1932 Washington growers have planted field peas on wheat fallow land. Table 2 shows the effect this has had upon the total production for the country. Total production has been greatly increased. This increased production has certainly influenced acreage planted to the crop in Michigan.

Table 2. Field pea production in bushels for leading states, 1929 to 1937 inclusive.
(000 omitted)

States	1929	1930	1931	1932	1933	1934	1935	1936	1937
Michigan . . .	351	308	128	190	180	165	182	104	99
Wisconsin . .	465	435	262	225	306	310	156	57	60
Montana . . .	388	525	446	364	294	330	576	391	342
Idaho	1,120	1,280	1,045	960	1,591	1,445	1,836	1,368	1,323
Colorado . . .	588	588	441	648	605	278	288	232	290
Washington . .				1,068	1,655	2,220	2,632	2,240	3,096
Oregon						66	87	40	21
TOTAL	2,912	3,136	2,322	3,863	4,631	4,814	5,757	4,432	5,231

Acknowledging the influence that pea aphids, weevils, and increased competition have had upon Michigan field pea production, studies were made at the Upper Peninsula Agricultural Experiment Station at Chatham to determine if there might not be other contributing factors.

Samples of peas grown in Chippewa County were obtained in each of four years 1935 to 1938, inclusive, and screened for size. For the same years sizing was also made on O. A. C. 181 field peas grown at the Chatham station. Samples of Chippewa County-grown O. A. C. 181 were also screened for size for the years 1936 to 1938 inclusive. After three years of production in Chippewa County, a sample of O. A. C. 181 peas was planted at Chatham and the resulting crop screened for size. In the meantime one generation of peas was grown at Chatham from each of the four samples of native Chippewa peas and the resulting crops screened for size. In every case a 16/64 round hole screen was used for sizing since the Michigan market demands a field pea of that size.

More than 90 per cent of the native Chippewa peas passed through a 16/64 screen which meant that nine-tenths of the crop, as based on the samples, were cull to begin with. Under such conditions there was no market for Michigan peas and growers the following year reduced their acreages. When the native Chippewa peas were grown at the Chatham station one year the resulting crop screened 40.7 per cent marketable as compared with 9.4 per cent for the originals. For the same years the O. A. C. 181 variety grown at Chatham screened 78.0 per cent marketable. The same variety grown in Chippewa County in a three-years test screened 55.6 per cent. When the variety was returned to Chatham and planted with the same variety grown continuously at the Station the former screened 74.2 and the latter 86.1 per cent, respectively.

Climatic conditions for the two areas were of course different and there is no doubt that size of pea is influenced by growing conditions. Even so, the study indicates that proper choice of variety would improve the marketability of the crop.

Under Chatham conditions, rate of seeding and date of planting had very little influence upon size as shown in Table 3. A rate of seeding of two bushels per acre for O. A. C. 181 at Chatham is recommended since higher rates did not increase yields. There is apparently a wide range within which field peas can be planted for best returns. Early planting is more important on the lighter soils, while heavy soils can be planted later. The latter are usually cooler and wetter early in the spring.

Table 3. Effect of rate of seeding and time of planting upon yield and size of peas grown at Chatham.

Rate or Date of Seeding	Yield: Bushels per Acre		Per cent Larger than 16-64 Screen
	*1934-39	1937-39	
1 bushel per acre.....		14.2	60.1
1½ bushels per acre.....		17.0	58.7
2 bushels per acre.....		18.4	61.2
2½ bushels per acre.....		18.5	58.6
3 bushels per acre.....		18.4	60.6
Average.....		17.3	59.8
Earliest possible.....	19.3	13.3	60.2
1 week later.....	19.8	14.9	59.0
2 weeks later.....	18.1	15.2	63.0
3 weeks later.....	18.3	16.4	58.9
Average.....	18.9	15.0	60.3

*Five-year average. No yield data in 1936

In addition to size, the marketability of field peas depends upon their color. Because humid conditions often prevail in Michigan at harvest time it is very difficult to grow a bright green colored pea that can compete with the Alaska peas of the West. The cream-colored varieties are therefore recommended. One of the characteristics of the native Chippewa County peas is the wide range in color from light cream to pale yellowish green. This condition is undoubtedly correlated with the semi-ever-blooming characteristic which the variety often shows. At Chatham the native Chippewa peas were later in beginning to bloom and continued to bloom almost to harvest time even though most of the seed was ripe. The plants themselves remained green longer and failed to ripen uniformly.

The O. A. C. 181 variety is earlier than other varieties tested at Chatham, ripens uniformly and has yielded slightly higher than Golden Vine, the variety formerly grown in much of the field pea growing districts of the state. The size of O. A. C. 181 peas is for the most part satisfactory although in adverse seasons the percentage larger than 16/64 is low. Of the varieties tested, it meets the requirements better than any other. In 1936 small lots of this variety were distributed from the Chatham station to four growers in Ontonagon, Chippewa, and

Alpena counties. Two Chippewa growers in 1939 produced approximately 2,000 bushels, three-fourths of which will be sold for seed.

To preserve the bright color as much as possible the peas should be stacked indoors or, if threshed from the field, put up in McNaughton stacks. Such stacks are easily built and keep the peas in good condition even through adverse weather. The essentials of this system are a straw base, a central pole around which the peas are piled, and a narrow stack (not more than 5 feet in diameter) with vertical sides.

Recommendations

Since the O. A. C. 181 variety under Chatham tests proved superior, it is recommended for the field pea growing districts of the state.

To keep insect pests and diseases at a minimum, grow peas in a four-year or longer rotation and practice fall plowing.

Plant from 2 to 2½ bushels per acre on a clean, well prepared seedbed.

If threshing is to be done outside, use the McNaughton system of stacking.

Adjust belt pulleys on cylinder of thresher so the cylinder speed can be reduced without changing the speed of the cleaning apparatus. This adjustment will result in fewer cracked peas. Split and undersized peas can be used as a protein supplement for feeding livestock. For this purpose they have approximately one-half the value of cottonseed meal.

If improved practices are used, the field pea acreage of the state can be considerably expanded.

RESULTS OF ALFALFA GRASS MOLASSES SILAGE EXPERIMENTS AT THE UPPER PENINSULA EXPERIMENT STATION

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SECTION OF FARM CROPS

The successful preservation of high quality roughages in the upper peninsula of Michigan has always been a major problem, the chief influencing factor being excessive rains at haying time. Since frequency of rains is more important than amount of precipitation, the former is given in Table 1 for the 10-year period 1926-35 at Chatham. Even for the driest period the table shows rain one day in three. The need for a more satisfactory way of preserving the feeding value of roughage is apparent and investigations started in 1935 at the Chatham station are in line with this need.

*Acknowledgments are due Dr. L. A. Moore of the Dairy Department for performing the carotene tests.

Table 1. Frequency of rains and mean temperatures at Chatham, Mich., for the years 1926-1935, inclusive.

Period	Average Mean Temperature	Per cent Days with Rain
June 20 to June 30.....	62.6° F.	52.7
July 1 to July 10.....	63.6° F.	43.0
July 11 to July 20.....	65.9° F.	41.0
July 21 to July 31.....	66.4° F.	35.5
August 1 to August 10.....	64.9° F.	36.0

Results of Experiments in 1935 and 1936

Late in September 1935, approximately 25 tons of an alfalfa grass mixture was placed in an upright silo. Beet molasses at the rate of 40 pounds per ton of roughage, was thinned with an equal amount of water and added at the blower by gravity feed. (Fig. 1.)

The silage was fed to Holstein dairy cows in experimental feeding trials covering 105 days. Results of these feeding trials were reported by R. E. Horwood.* In general, the work indicated that alfalfa grass molasses silage on a dry weight basis could replace hay in the ration pound for pound. Twenty-five tons were again put in the silo in

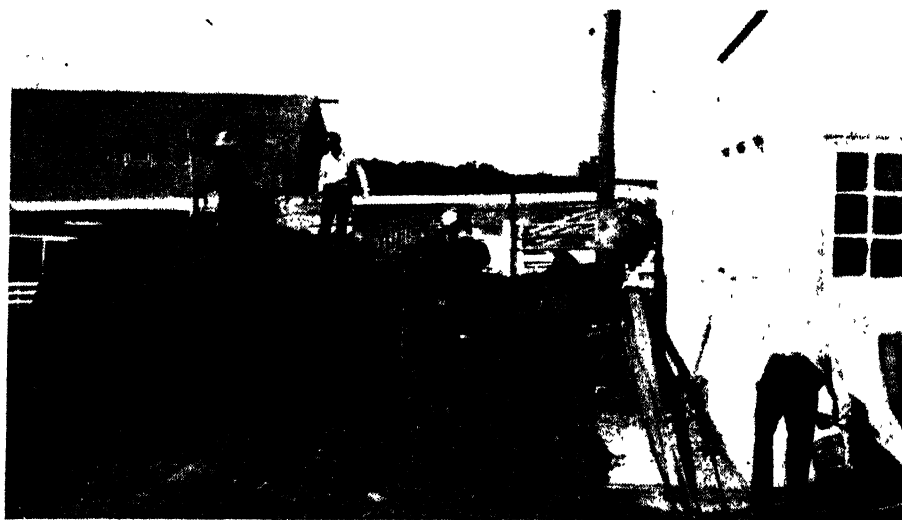


Fig. 1. Two per cent by weight of beet molasses was thinned with an equal amount of water and added by gravity feed through a hose to the chopped hay at the blower. The molasses can also be added to the hay at the throat of the machine. In 1939, an automatic pump was attached to the cutter which proved very satisfactory both in accuracy and ease of applying the molasses. Ropes, poles, and fencing have been used on the bottom of the load to upset the load at the cutter. This affords economical use of racks and helps to reduce the cost of ensiling.

*Horwood, R. E., Alfalfa molasses silage vs. alfalfa hay as a roughage for lactating dairy cows. Mich. Agr. Exp. Sta. Quart. Bul. 19 (2): 100-104, 1937.

September 1936 but in contrast to the 1935 work the roughage was predominantly grass. One lot of quack grass (7 tons) was ensiled in June and the remainder, a grass-legume mixture, in September. The silage was again fed to the dairy herd. Results of both years indicated that the biggest problem was in the making of the silage. Since then the chief emphasis has been on methods of ensiling.

Results of Experiments in 1937

In 1937 several lots were ensiled and the data for eight of these lots are summarized in Table 2. Protein was well preserved in every lot. Table 2 shows an increase in protein from the time of ensiling to feeding; however, the difference is not significant in some cases. Error involved in sampling (only one sample was taken for each lot) may account for some of the difference. Likewise the increase may, to some extent, be due to a decrease in other dry matter, particularly the soluble sugars. On a dry weight basis the silage contained approximately twice as much protein as the hay fed. The former was from second cutting while the first cutting was used for the hay.

All lots contained approximately the same total soluble sugars when ensiled and in every case they had largely disappeared by feeding time. When the silage was fed out, the lot receiving no preservative contained the least amount of sugars but the difference was not significant.

The carotene content of silage sealed in fruit jars and buried in each lot indicated that the hays were well supplied with carotene and that the latter could be preserved if silage could be stored in an airtight container. Much of the carotene was lost, however, from silage of each lot in the silo itself. The fact should be emphasized, however, that the carotene remaining in the silage is several times greater than the carotene content of the hays fed. Wilting of the forage before it was ensiled resulted in some loss of carotene and one should remember that the amount of carotene lost depends upon the amount of wilting and conditions prevailing at time of wilting. Despite this loss of carotene through wilting, however, the wilted lots contained slightly more carotene when fed than lots ensiled immediately after cutting. Neither sugar nor molasses aided in preserving the carotene. Where extra water was added, the carotene was preserved somewhat more efficiently, however this was due to the high carotene content of lot 13 which was the lot fed first. Previous years' work showed that the longer silage was stored the less carotene it contained.

Since thorough packing depends upon moisture content and fineness of cut the latter was determined for each lot by separations. A definite known quantity of thoroughly dried silage from each lot was separated into five grades on the basis of length. The five grades contained material less than $\frac{1}{4}$ inch, $\frac{1}{4}$ to $\frac{1}{2}$ inch, $\frac{1}{2}$ to 1 inch, 1 to 2 inches and more than 2 inches in length, respectively. On this basis the modulus or fineness of cut was determined.

Hays ensiled immediately were chopped finer than hays that had been wilted and had a lower modulus, as shown in Table 2. A higher percentage of the hay ensiled immediately after cutting was in the finer grades and a lower percentage in the coarser grades. Wilted hay was more difficult to run through and required more time.

Table 2. Effect of moisture, molasses, and other factors upon feeding value of silage as expressed in protein and carotene content. Results of 1937 experiments at the Upper Peninsula Experiment Station, Chatham.

Lot No.	Treatments	Fineness of Cut or Modulus	Per Cent Moisture When		Per Cent Protein When		**Per Cent Total Soluble Carbo- hydrates When		Acidity When		**Carotene When Fed	
			Ensiled	Fed	Ensiled	Fed	Ensiled	Fed	Ensiled **Buffs	Fed pH	Sealed Jars	Open Silos
2, 4, 13	Ensiled immediately after cutting.....	2 03	75 0	73 0	15 08	17 26	3 1	.24	205 0	5 08	***220 6	71.3
9, 10, 11, 12	Wilting before ensiled....	2 37	49 2	57 3	15 42	18 51	3 6	.45	192 5	5.14	188 3	90 9
2, 10	No preservative.....	2 08	62 2	63 9	15 69	17 74	3 0	.18	210 0	4 76	202 5	95 4
4, 11	1% cane sugar.....	2 43	63 8	63 4	14 85	17 73	3 9	.42	195 0	4.67	202 3	65.3
6, 12.....	2% beet molasses.....	2 25	52 0	65 1	14 47	18 85	3 0	.44	195 0	5.37	189 8	62.8
9, 13	2% beet molasses and water*.....	2 05	60 6	68 2	16 00	17 21	3 6	.34	195 0	5.63	223 3	101.0

*Where molasses was added, an equal amount of water was added to thin out the molasses. In this particular instance, however, additional water was added through a separate hose.

**Calculated on a dry weight basis.

***Micrograms per gram of dry matter.

Table 3. Effects of moisture, molasses, and other factors upon the feeding value of silage as expressed in protein and carotene content. Results of 1938 experiments at the Upper Peninsula Agricultural Experiment Station, Chatham.

Lot No.	Treatment	Per Cent Legumes	Per Cent Moisture When		Per Cent Protein** When		**Per Cent Total Soluble Carbo-hydrates When		Acidity When		Carotene** When		
			Ensilaged	Fed	Ensilaged	Fed	Ensilaged	Fed	Ensilaged Buffers**	Fed pH	Ensilaged	Sealed Jars	Open Silo
1	1/4-1/2 bloom ensilaged immediately, no preservative	36.1	63.2	63.2	10.56	12.54	4.51	2.02	108.5	4.76	***160	131	16
2	1/4-1/2 bloom ensilaged immediately, 2% beet molasses	31.5	66.1	64.2	11.13	13.20	6.17	2.03	105.0	4.24	153	127	46
3	1/4-1/2 bloom wilted 2% beet molasses	30.2	58.1	57.9	10.94	12.57	5.59	2.64	100.0	4.73	125	127	28
4	1/4-1/2 bloom ensilaged immediately, 2% beet molasses, longer cut	28.2	68.0	69.0	11.88	12.06	5.31	2.01	115.0	4.51	150	115	39
5	Late full bloom ensilaged immediately, 2% beet molasses	65.2	65.0	66.5	11.56	15.98	5.43	1.25	90.0	4.26	170	94	52

**Where molasses was added, an equal amount of water was added to thin the molasses.

***Calculated on a dry weight basis.

Micrograms per gram of dry matter.

Results of Experiments in 1938

In 1938 fewer lots were ensiled but more silage was put in each lot. A summary of 1938 results is given in Table 3.

Hays ensiled in 1938 were less mature than hays ensiled in 1937, contained less moisture, less protein, less acid as indicated by buffer tests, less carotene and more total soluble carbohydrates. Four of the lots were approximately $\frac{1}{3}$ legumes and one lot nearly $\frac{3}{4}$ legumes. In 1937, lots varied from 72 to 80 per cent legumes. The percentage of protein was again higher in silage fed out than the hays ensiled; however, the difference was not significant except in lot 5.

The percentage of protein for all lots in 1938 was lower than for any lot in 1937. This difference is undoubtedly due to a difference in the condition of the hays at the time of ensiling and to the fact that in 1937 a much higher percentage of the roughage was legumes.

The total soluble carbohydrate content of the roughage when ensiled was considerably higher in 1938 than in 1937. Silage when fed contained a high percentage of soluble carbohydrates in 1938 whereas in 1937 the soluble carbohydrate content was very low. Acidity of the roughage, when ensiled, expressed as buffers in both tables 2 and 3, was twice as high in 1937 as in 1938. The average pH of all lots receiving 2-per cent molasses in 1937 was 5.50 when fed compared with 4.50 for the average of all similarly treated lots in 1938.

Sealing the silage in air-tight jars again indicated that proper sealing preserved more of the carotene. In the open silo a high percentage was lost; however, again the silage fed contained several times more carotene than did the hays made from first cutting. Wilting again resulted in a loss of carotene, though as much was preserved as in some of the lots ensiled immediately after cutting.

Practical Application

From a technical viewpoint, the results of the four years experiments are inconclusive. However, from a practical angle several facts have been brought out.

Under conditions prevailing at Chatham, hays can be made into a silage that on a dry weight basis is equal to cured hay. The protein content of such silages is usually higher than hays made from first cutting. Hay silage is not so easily preserved as silage made from such crops as corn or sunflowers. There will be some spoilage especially at the top and near the doors. Spoilage at Chatham has amounted to slightly more than 15 per cent, though it should be remembered that all spoiled silage was discarded and there was a considerable amount of good silage discarded with it in order to be sure none of the former was fed to the cows on experimental feeding. The spoilage most of which is at the top, emphasizes the importance of packing and covering with some material. One of the best plans in this connection would be to weight the hay silage down with a few tons of corn or sunflower silage.

Though considerable carotene in the silage was lost each year at Chatham, the fact remains that the carotene preserved amounted to several times the quantity found in first cutting hay fed at the station.

The moisture content of the hay to be ensiled can vary considerably. A moisture content ranging from 60 to 70 per cent is most satisfactory.

The use of molasses is recommended, although there is some indication that where the hay is a mixture of grasses and legumes the silage in the bottom of the silo will keep without the molasses.

Any device or method which will help to reduce the cost of silage should be utilized. At Chatham, windrowing the hay before picking it up with the loader was not necessary but the loader should be made of extra heavy material to handle the green hay. Any device that can be used to turn the hay off the rack at the cutter will save the expense of a rack, man, and team or truck. An automatic pump will give an even distribution of molasses and save the labor of another man.

A COMPARISON OF CARROTS, "GREENMELK" AND DEHYDRATED ALFALFA LEAF MEAL IN THE LAYING RATION

J. G. WELLS, JR. AND J. A. DAVIDSON

U. P. EXPERIMENT STATION AND SECTION OF POULTRY HUSBANDRY

Feed stuffs that carry carotene (commonly referred to as Vitamin A) have been shown to be necessary for normal growth and reproductive processes of poultry. Carotene is supplied by yellow corn and carefully sun-cured or dehydrated legumes (usually alfalfa). In addition to those sources, Vitamin A is supplied by fish oils in varying amounts, depending on the fish from which it is extracted.

The problem of supplying green feed or a substitute for green feed in the laying ration is present in Michigan during the winter months. When yellow corn is not readily available and barley and wheat are the principal cereals used, the problem of supplying adequate amounts of Vitamin A is especially difficult.

In 1926, Davis and Beach (1) found that yellow or red carrots fed to 4-months-old pullets prevented symptoms of Vitamin A deficiency. Fraps and Treichler (2) state that yellow raw carrots contained 67 units of Vitamin A per gram, compared with 50-66 in machine-dried alfalfa leaf meal, and Miller and Bearse (4) found that dehydrated carrots compared favorably in Vitamin A potency with dehydrated alfalfa and dehydrated grass. The fact that carrots are generally grown throughout the Upper Peninsula, suggested that feeding trials using carrots as a supplementary feed to the laying ration be undertaken in that section.

In 1937 an attempt was made to utilize raw carrots, fed daily, but they were not readily accepted by the laying pullets and did not assume a role of any importance. Accordingly, it was thought that cooking the carrots would increase their palatability and thus increase consumption.

The 1938-39 Trial

PROCEDURE

Three pens of approximately 100 birds each of White Leghorn pullets of the same ages were used. They were fed laying mash, as shown in Table 1. The check pen received 8 per cent dehydrated alfalfa leaf meal; one of the two remaining pens was fed cooked carrots, and the third pen, "Greenmelk." Greenmelk is a commercial preparation of condensed milk in which dehydrated cereal grass is incorporated, to supply carotene as well as other materials furnished by grass and milk.

Whole oats and oyster shell was fed *ad lib*. Gravel was used as grit.

A grain mixture of 60 pounds of wheat and 40 pounds of barley, to which was added 2 pounds of sardine oil, was also fed *ad lib* in open feeders.

Table 1. Laying mash.

Ingredient	Carrot-fed Pen	"Greenmelk"-fed Pen	Alfalfa-fed Pen
Ground barley	20	20	20
Wheat bran	20	20	20
Flour middlings	20	20	20
Ground oat groats	12	12	12
Meat scraps	11	11	11
Soybean oil meal	5	5	5
Dried milk	5	5	5
Alfalfa leaf meal (dehydrated)			8
Steamed bone meal	1	1	1
Salt	1	1	1
Sardine oil (100 units of D, 600 units of A)	2	2	2

Preparation of Carrots—The carrots used were Chantenay yellow. They were weighed before cooking; generally they were steamed 15 minutes in water by introducing live steam. When steam was not available they were cooked in water just below the boiling point. This treatment softened them sufficiently to increase their palatability and they were accepted by the birds. They were fed on top of the dry mash at 11:30 a. m. daily.

"Greenmelk" Preparation—This product was fed at the rate of 2 pounds per hundred birds, which is one-third less than recommended by the manufacturer. However, 5 per cent of dried milk was included in the laying mash. The "Greenmelk" was diluted, slightly, with water and fed on top of the dry mash at 11:30 a. m. daily.

Discussion of Results

The feed consumption by the different pens over the 6-month period is shown in Table 2. The total feed consumed by the carrot-fed birds was greater than for either of the other groups. This was due to the quantity of carrots fed. The quantity of carrots fed the first two months was very great owing to the caretaker's feeding all that the birds would eat. During December the birds consumed as much as 10 pounds of carrots (cooked) daily per hundred birds. This was probably too much, judged by the reaction of the flock.

Table 3 shows the total number of eggs obtained, the percentage egg production on the hen-day basis, and the number of birds dying

Table 2. Average feed consumption per bird in pounds.

Month	Carrots					"Greenmelk"					Check			
	Mash	Grain	Oats	Shell	Carrots	Mash	Grain	Oats	Shell	"Greenmelk"	Mash	Grain	Oats	Shell
November...	3.05	2.80	1.40	.35	2.90	2.58	3.30	1.48	.36	.57	2.66	3.86	.85	.35
December...	3.28	2.67	1.51	.23	2.26	2.73	3.64	1.79	.29	.64	3.07	3.58	1.63	.25
January...	3.74	4.30	1.76	.37	1.81	2.84	4.01	1.80	.37	.62	2.83	4.54	1.67	.34
February...	2.14	3.33	1.58	.21	1.31	1.83	3.63	1.62	.20	.57	1.88	3.48	1.62	.11
March.....	2.51	4.03	1.21	.10	1.42	2.60	4.71	1.28	.14	.66	2.11	4.45	.94	.10
April.....	3.01	4.29	1.26	.20	1.37	2.54	4.51	1.00	.16	.66	2.22	4.45	.90	.21

each month. The egg production of the "Greenmelk"-fed pen and the alfalfa-fed pen was approximately the same over the six-month period. The additional cost of the "Greenmelk" fed at the rate of 2 pounds per hundred birds was not warranted when using this particular laying mash, since the alfalfa would cost less than the Greenmelk. The question of whether the dried milk in the mash could be removed is not known. This is similar to the results obtained by Gish and Payne (3). They also observed that the period of winter pause was less, which was also true in this particular trial.

The carrot-fed pen produced fewer eggs without a saving in quantities of other feed consumed. It may be that the quantity of carrots fed at first was too high for optimum results. A further trial is in progress to determine if this observation is true.

The mortality over the six-month period was lowest in the group fed carrots and nearly the same for those fed "Greenmelk" and alfalfa meal. The mortality was 9 per cent on the carrot-fed pen, 14.4 per cent on the "Greenmelk", and 17 per cent on the alfalfa-fed pen.

The trial ended April 30 owing to the difficulty in keeping carrots in good condition for a longer period.

It should be noted that no yellow corn was used in these rations.

Vitamin A Storage of Livers and Vitamin A Content of Eggs

The Vitamin A content of the eggs was determined at monthly intervals. It was thought that this would give some information in

Table 3. Egg production hen-day and mortality.

Month	Carrot-fed			"Greenmelk"-fed			Check		
	Number Eggs	Per cent Production	Number Died	Number Eggs	Per cent Production	Number Died	Number Eggs	Per cent Production	Number Died
November...	1,458	48.6	0	1,401	48.2	1	1,246	41.7	1
December...	1,368	41.3	3	1,600	53.8	0	1,775	55.4	2
January....	1,713	56.9	3	1,449	49.8	4	1,831	61.4	0
February....	1,149	43.7	0	1,234	48.1	2	1,151	43.3	6
March.....	807	27.8	1	1,061	39.0	3	976	34.4	6
April.....	1,353	49.3	2	1,306	51.3	4	1,352	52.1	6
Total.....	7,848	45.3	9	8,051	48.4	14	8,331	48.8	17

Table 4. Vitamin A content of livers.
(Blue units per gram)

Carrot-fed		"Greenmelk"-fed		Check	
Number Eggs Laid by Bird	Blue Units Per Gram	Number Eggs Laid by Bird	Blue Units Per Gram	Number Eggs Laid by Bird	Blue Units Per Gram
103	3,040	108	267	101	221
112	1,110	108	1,300	112	714
128	1,480	125	1,075	125	246
144	1,920	165	1,180	154	716
Ave. 121.7	1,887.5	126.5	955.5	123.0	474.2

respect to the efficiency of the green feed substitute. The results of these determinations are shown in Table 5. The figures given are taken from a sample pooled from one dozen eggs for each month. The amount of Vitamin A in the carrot-fed and Greenmelk-fed pens remained about the same over the entire period. There was a gradual reduction of Vitamin A in the eggs from the alfalfa-fed pen. This indicates that the quantity of alfalfa consumed did not supply sufficient Vitamin A.

Four birds from each group were killed at the end of the trial and the livers assayed under the supervision of Dr. C. A. Hoppert, professor of biochemistry. The Carr-Price reaction method giving a blue color through the use of antimony trichloride was used and the blue units per gram are shown in Table 4. One blue unit is approximately equal to one and one-half U.S.P. units of Vitamin A. The liver of one bird from the carrot-fed pen showed an unusually high storage of Vitamin A, and one bird on the "Greenmelk"-fed pen showed a low amount. Disregarding these two individuals the carrots gave better results than the "Greenmelk"-fed pen. Those receiving alfalfa were lower than either of the other two pens. This again indicates that the quantity of alfalfa consumed was not sufficient. Again attention should be called to the fact that no yellow corn was used.

While there is considerable debate as to the effect that Vitamin A has on mortality, this trial indicates that higher Vitamin A intake may reduce mortality to some degree.

Summary

Chantenay yellow carrots may be used as a source of Vitamin A (green feed substitute). Presumably any other variety of yellow car-

Table 5. Vitamin A content of eggs.
(Blue units per gram)

Month	Carrot-fed	"Greenmelk"-fed	Check
January.....	17.5	11.5	16.3
February.....	18.4	17.6	15.5
March.....	15.7	15.5	10.7
April.....	15.1	18.4	9.8

rots will give similar results. The liver storage of Vitamin A was higher on the carrot-fed pen than the liver storage of the birds fed 8 per cent of dehydrated alfalfa leaf meal in the mash. Thus it may be stated that 4 to 5 pounds of the raw carrots (cooked) per day is sufficient for 100 birds when yellow corn is not used.

"Greenmelk", when fed at the rate of 2 pounds per 100 birds per day, did not produce any better egg production, although the cost was greater. The liver storage of Vitamin A and the Vitamin A content of the eggs was higher for the "Greenmelk"-fed pen, than for the check pen.

The amount of sardine oil used was in excess of that necessary for egg production.

There is an indication that mortality is lower by feeding increased amounts of Vitamin A, though the differences were not great enough to warrant a definite conclusion in this respect.

Where yellow carrots are available and alfalfa products of good quality are not available, or are available at higher prices, the flock owner may use carrots with a reasonable chance of supplying the laying birds' needs for green feed during the winter months.

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A STUDY OF CREAM QUALITY FROM CREAMERIES LOCATED IN SOUTHERN MICHIGAN

J. I. M. JENSEN
SECTION OF DAIRY HUSBANDRY

The cream purchased for buttermaking in Michigan is quite generally bought without being segregated into quality grades; and no price differential is offered by buyers of cream except in a few small creameries. Many persons in the dairy industry believe that real improvement in quality will come only when the cream is graded and there is a difference in price between good and poor cream.

Creamery operators believe that cream grading is necessary in order to improve quality and realize that good cream is worth more to them than cream of poor quality. The difficulty the creamery operators encounter in putting into force such a plan is a lack of control in uniform grading. A grading plan is sought that is adaptable to cream station buying as well as to creameries of all sizes.

A study was made during October on the quality of cream purchased by four large creameries located in adjoining areas in southern Michigan. An attempt was made to determine the cream quality as it existed in those factories by the use of the rapid acid test and by taste and smell.

The creameries in which these studies were made manufacture butter which usually scores from 90 to 91, with a few churnings scoring 89 and some butter scoring 92. One of these creameries grades cream so that it is able to satisfy a market with 92, 90, and 89 score butter. The other three creameries make but one grade of butter, rejecting only a few cans of cream of particularly bad flavor or cream that is illegal in sediment content.

Procedure

The cream from each creamery was gathered two times each week, which would make one shipment four days old while the other shipment would be three days old. In each instance assurance was given by creamery operators and truck drivers that the cream from each patron was gathered twice each week, irrespective of the amount.

The cream was stirred for sampling; following that, each can was graded by taste, to determine whether the cream would make butter scoring 92, 91 to 90, or less than 90. The rapid acid test was then performed, with each dipper of sodium hydroxide solution equivalent to 0.3 per cent acidity, calculated as lactic acid. The cream was segregated into acidity groups of (1) less than 0.3 per cent, (2) less than 0.6 per cent and (3) more than 0.6 per cent acidity. In most instances it was possible to determine the acidity group of samples by taste, the actual acidity test being made only to check on cream close to the border of each group. This means of acidity determination was necessary owing to the speed with which cream was handled in the receiving line.

The criticisms were recorded for the cream that was placed into the class of "less than 90 score".

The mean temperature of weather was recorded for four days preceding each day's delivery.

Results

The results of the study are presented in Table 1. A total of 5,925 cans of cream were graded. Of this 397 or 6.7 per cent were less than 0.3 per cent in acidity; 3,876 or 65.4 per cent were less than 0.6 per cent in acidity, while 1,600 samples or 27 per cent exceeded 0.6 per cent in acidity.

The score of cream was divided as follows: 1,427 samples or 24.0 per cent would make 92 score butter; 3,630 cans or 61.2 per cent would make 91-90 score butter, while 858 cans of cream, 14.48 per cent would make butter scoring less than 90.

An apparent degree of quality improvement is noticeable in three-day cream compared with four-day cream. This is especially apparent in the high percentage of cans in Creamery "D" grading 92 score. It is also made obvious by the fact that on the average a greater percentage of the four-day cream scored less than 90 in all creameries except Creamery "C".

The atmospheric temperature no doubt is responsible for quality

Table 1. Acidity and score of cream in cans and per cent.

Date	Creamery	Age of Cream (Days)	No. of Cans	Acidity of Cream						Score of Cream						Atmospheric Temperature	Average Vol. Acidity
				- 3%		- 6%		+ 6%		92		91-90		Less than 90			
				Cans	Per Cent	Cans	Per Cent	Cans	Per Cent	Cans	Per Cent	Cans	Per Cent	Cans	Per Cent		
October 4	A	4	375	22	5.8	224	59.7	129	34.4	50	13.3	238	63.4	87	23.2	54°	
October 5	A	3	734	61	8.3	436	59.4	237	32.2	152	20.7	459	62.5	123	16.7	59	
October 6	A	3	876	19	2.1	710	81.0	147	18.8	168	19.2	596	68.0	112	12.7	60	
October 10	B	4	199	1	5	79	39.6	119	59.7	5	2.5	123	61.8	71	33.6	67	
October 11	B	4	188	1	5	60	31.9	127	67.6	3	6	112	59.5	73	38.9	65	
October 12	B	3	476	5	1.0	309	65.0	162	33.9	59	12.4	299	62.8	118	24.7	58	
October 19	C	4	385	4	1.0	290	74.9	91	24.0	89	23.0	263	68.3	33	8.5	43	
October 20	C	3	438	5	1.1	227	51.8	206	47.0	71	16.2	292	66.6	75	17.1	48	
October 24	D	4	734	12	1.6	499	68.9	213	29.4	145	20.0	509	70.7	30	9.6	50	
October 25	D	4	580	74	12.7	380	65.5	126	21.7	186	32.0	358	61.3	76	6.2	48	
October 26	D	3	898	193	21.5	662	73.7	43	4.8	479	53.3	359	39.9	60	6.6	47	
Total			5,873	397	6.75	3,876	66.0	1,600	27.2	1,407	24	3,608	61.4	858	14.6		

deterioration, since the quality of the cream seemed to vary with the average mean temperature of the days the cream was held. This would indicate that few producers are using water cooling tanks for cream in the area studied. The temperatures were recorded more as a means of comparing cream quality from one season to another, rather than as a means of accounting for quality differences that were found from one creamery to another. It is likely, however, that the low number of samples scoring 92 for Creamery "B" is partly caused by the higher weather temperatures recorded.

Table 2 shows how the cream was scored in the different acidity groups. Frequently the acidity of cream is used as a gauge of its quality, with an acidity of 0.2 per cent used as the upper limit in sweet cream and an acidity of 0.6 per cent used as the upper limit of cream bought as "first grade". Three hundred eighty-five cans or 97 per cent of the cream of less than 0.3 acidity were given scores of 92. This would indicate that for cream of low acidity there is a close relationship between acidity and quality.

Table 2. Number of cans of cream showing score of cream in different acidity groups.

Per Cent Acidity	Score of Cream		
	92	91-90	90
- .3.....	385*	13	4
- .6.....	1,042	2,580	277
+ .6.....		1,037	577
Total.	1,427	3,630	858

Of the cream with more than 0.3 per cent acidity, but less than 0.6 per cent, as determined by the rapid acid method, there were 1,042 cans that were graded as material from which 92 score butter might have been made*. This number constituted 26 per cent of the —0.6 per cent acidity group. The greater portion of the cans of cream in the group, 66 per cent, were placed in the 90 to 91 score class. Also in this group 277 cans, or 7 per cent, were scored less than 90. These cans were criticized largely for such flavors as are due to water dilution separating.

Relying on acid testing alone as a grade standard would permit inclusion of a considerable portion of cream of poor quality.

Sixty-four per cent (1,037 cans) of the cream that was more than 0.6 per cent in acidity, was placed in the 90-91 score group; while the rest, 36 per cent, was scored less than 90. Thus the grading of cream by acidity alone would not be practical for creameries wishing to make more than one grade of butter. This emphasizes the necessity for having a well trained cream grader in each cream buying station and creamery.

It should be borne in mind that insufficient data are available to

*The cream samples in the —.6 per cent acid group that were given 92 score possessed only mildly sour flavor. The vat tests from 92 score cream churnings ranged between 0.3 and 0.4 per cent acidity.

Table 3. Summary of cream acidity and score.

Creamery	No. Cans	Acidity			Score		
		Under .3%	Under .6%	Over .6%	92	91-90	Under 90
A.	2,005	102	1,370	513	370	1,313	322
B.	873	7	448	408	67	534	262
C.	825	9	517	297	160	557	108
D.	2,222	270	1,541	382	830	1,226	166

determine actually the butter score from the score of cream. Much will depend upon the skill of the buttermaker in processing factors, such as neutralizing, pasteurizing, and developing desirable flavors from starter. It is believed, however, that buttermakers are more skillful in processing sour cream now than formerly and are able to make butter of higher score from sour cream than was possible a few years ago.

Table 3 shows the summary by creamery. A considerable difference was found in the quality of cream bought at the four different plants. In plant "A" some quality work has been done in the past. The creamery is very modern. The cream is hauled in well constructed, semi-insulated trucks. The main drawback to quality improvement here lies in the fact that commission haulers are engaged in cream gathering. A high rate of commission is paid which encourages too aggressive action for quantity.

Creamery "B" has done little quality work. The plant buys a substantial portion of cream through stations, while the bulk is gathered in open-bodied trucks operated by commission haulers.

Table 4. Flavor criticism of cream scored less than 90.

Description of Flavor Criticism	Creamery				
	*A	B	C	D	Total
Metallic.	26	18	1	10	55
Water unclean.		15	23	20	58
Water metallic.	15	29	7	33	84
Oily.			1	6	7
Old cream.	80	144	71	72	237
Yeasty.	1	18	4	14	37
Feed.	4	2	1	3	10
Cheesy.	1			3	4
Cow.			2	3	5
Bitter.	3				3
Moldy.	1				1
Unclean.	2				2
High acid.		27			27
Musty.	1		1	3	5
					*535

*The cream received during the first day at Creamery "A" was graded without noting criticism of cream that was scored less than 90.

Creamery "C" has done some quality work in the past, largely in sediment testing and by educational programs held in conjunction with the annual creamery picnic. The plant is quite modern and is well operated. The cream is delivered in enclosed trucks. The trucks, however, have floor openings which permit dirt to enter and are not insulated.

Creamery "D" has been grading cream into similar grades as those used in this study. They have not been paying for cream on a grade basis, but have made many farm visits on quality matters. They periodically circularize each patron with suggestions for quality improvement practices. There was a remarkable degree of better quality cream received by this creamery than by the other creameries in this study.

Cream grading less than 90 in score was criticized for flavor defect. Fourteen different flavor defects were found. The highest number of flavor defects were found to be the "old cream" flavor. It can be said, however, that this is one of those convenient flavor criticisms that is frequently used for lack of a more exact description. One of the most pronounced defects found in cream flavor in this area was that caused by water in cream. This condition was responsible for the flavors listed "water-metallic", "water unclean" and for perhaps most of the "metallic" flavors. Water dilution separators and permitting water to enter the cream from rinsing is the cause of these off-flavors. The "high acid" and "yeasty" lots were largely confined to creamery "B" where the temperature range during home storage was relatively high.

Summary and Conclusions

The results obtained in this study show that a wide spread exists in the quality of cream purchased for buttermaking. Some producers apparently give cream considerably more care than do others.

It would appear that cream cannot be graded entirely by acid test, since only 6.7 per cent of the cream was less than 0.3 per cent in acidity, whereas 24.08 per cent of the cream was scored 92. Also 27 per cent of the cream tested more than 0.6 per cent acidity, whereas only 14.8 per cent of the cream was scored less than 90.

The atmospheric temperature during the days the cream was accumulated and shipped to the creamery influenced the quality appreciably. The warmer the weather, the higher was the acidity and the greater the percentage of cream that scored less than 90. This would indicate that very few producers use water cooling equipment for holding cream accumulations until marketed.

On the whole, the cream which was held three days was of better quality than that held four days.

The flavor criticisms of cream scoring less than 90 are of such types as those that are due to improper cream storage and to water contamination. The cause of most cream's being criticized as "watery" and "metallic" was thought to be due to the producer's skimming with water dilution separators.

Differences existed in the quality of cream purchased by the different creameries. Some of these quality differences were caused by variations in atmospheric temperature. It was also apparent that the better quality existed in creameries that place the most emphasis on quality.

HURON, A NEW OAT VARIETY FOR MICHIGAN

E. E. DOWN AND J. W. THAYER
SECTION OF FARM CROPS

A new oat variety, characterized by a high degree of resistance to smut and grain of markedly superior test weight, has recently been developed through cooperative effort of the Michigan State College and the United States Department of Agriculture. Given the name, "Huron", a typical Michigan name of Indian origin, this new oat has been increased to the point where pure seed is available for general distribution.

The parent material from which the Huron oat was bred came from a cross between the Markton and Victory varieties originally made by G. A. Wiebe at Aberdeen, Idaho, in 1923. The Markton oat was selected by the United States Department of Agriculture from seed of Turkish origin and is characterized by its immunity from smut, while the Victory oat, an excellent plumpkerneled white variety was developed in Sweden. A number of selections from this cross were sent to the Farm Crops Section of the Michigan Experiment Station by T. R. Stanton, Division of Cereal Crops and Diseases of the United States Department of Agriculture in 1929.

One of these U. S. D. A. selections, which carried the identification number C.I. 2590 had, by 1932, demonstrated superior merit in the Michigan trials. Plant selections made in 1932 and tested in 1933 demonstrated that C.I. 2590 was still impure from a genetic standpoint and produced hereditary variations in such characters as plant height, maturity, and weight and quality of grain. Two of these selections, numbered 5210 and 5211, were promising enough in performance to warrant testing them thoroughly in several parts of Michigan. The strain numbered 5210 appeared to best advantage in these trials, so a quantity of seed was produced in 1938 sufficient to plant approximately 90 acres and the seed, in 1939, was planted by five farmer-cooperators in order further to increase the seed and to obtain field observations on performance. The harvest of these 1939 increases which in all cases brought grain of superior quality, and the continued excellent performance of this selection in comparative over-state trials indicated that this selection, now named Huron, had characteristics of sufficient value to warrant its introduction for general commercial use.

The merit of the Huron oat is demonstrated when its performance is compared with that of the Wolverine variety chosen for this comparison because the Wolverine oat is widely grown throughout the lower peninsula of Michigan where for many years its performance has made it Michigan's most popular oat variety. The Wolverine oat was also developed at the Michigan Experiment Station and introduced in 1918,

started to head. This caused Huron to lodge and it never recovered whereas Wolverine did not lodge. In 1937, the Huron ripened several days earlier than Wolverine in Sanilac County but harvesting was delayed until Wolverine was ripe, a disadvantage to the early strain.

Smut Resistance

The smut resistance of the Huron oat was definitely determined as selections were made and further verified in 1936 and 1937, when 80 rows were planted to seed originating from single plants and the seed was thoroughly inoculated with a mixed sample of smut spores. None of the plants developed any smut whatsoever. Undoubtedly the Huron variety does not need to be treated with any disinfectant to control smut. The seed used in the trials reported herewith was not treated and no smut developed in the Huron variety.

Maturity

Time of heading can usually be used as a direct measure of the relative maturity of two varieties of oats. For example, Logold oats, an early variety, will head and also ripen from 7 to 9 days earlier than Wolverine. The Huron oat, however, is different in that respect. In the East Lansing trials (Table 1), it headed an average of 7 days earlier than Wolverine but ripened fully only 2 to 4 days earlier. This means that Huron has a longer time between heading and ripening than Wolverine, a fact which may account for its unusually high test weight.

Like its high test weight, the earliness in date of heading of the Huron oat is not a characteristic of either of its parent varieties. Markton, the earlier of the two parents, heads 2 or 3 days earlier than Wolverine and tends to retain this same spread in time of ripening. Victory, the other parent, is a little later in both heading and ripening than Wolverine.

Stiffness and Height of Straw

The Huron variety normally has a somewhat shorter straw than Wolverine, the difference usually being around 4 inches. It is definitely stiffer in straw than its Markton parent, but is not superior to Victory or Wolverine in this respect. At present, the Huron variety is recommended for those soils in the lower peninsula of Michigan where the Wolverine variety is adapted.

Summary

The Huron is a high yielding, medium early, high test weight, highly smut resistant, yellowish grained variety of oats that was selected from a cross made between Markton and Victory.

The plants are about four inches shorter and have approximately the same stiffness of straw as Wolverine. It is recommended for those soils of the lower peninsula of Michigan where Wolverine oats are known to be satisfactory.

BULLETIN REVIEWS

Cir. Bul. 171.—Alfalfa Bacterial Wilt in Michigan.—Muncie, J. H. and Megee, C. R.—Bacterial wilt of alfalfa has spread rapidly until fields in 20 counties have been found affected. Weakening of the plants by this disease often leads to severe winter injury. The causal bacteria live over from year to year in the soil in old infected roots and are carried from one part of the field to another in surface water. The bacteria are also carried on the mower knife in cutting diseased fields. Apparently all common varieties of alfalfa are affected by wilt. Grimm and Hardigan are readily killed by the disease but Ladak seems to be much more resistant. Seeding smooth brome grass with alfalfa seems to reduce the spread of wilt in the field. (11 pp., 2 figs.)

Spec. Bul. 300.—The Kalamazoo Milk Market.—Ulrey, O.—A study of the distributive channels and competition in marketing milk in the area, the production and utilization of milk in the county, inspection of milk in Kalamazoo, organization and functions of the Kalamazoo Milk Producers' Cooperative, number and size of milk distributors, handling of welfare milk, operation of the federal marketing agreement and license, and a description of the milk prices and price plans for selling milk in the Kalamazoo market. The Kalamazoo milk market was studied by many groups of producers and distributors during 1938 and 1939 because prices to producers and retail prices were maintained, while most of the other milk markets of the state were in a chaotic condition. Consequently, the primary purposes of the study were to explain the reasons for the relative stability of the market, and to describe the facilities, institutions and market practices. (44 pp., 34 tables, 9 figs.)

Tech. Bul. 167.—Use of Fertilizers and Lime on Native Pastures in Michigan.—Tyson, J.—Results are presented of a series of field fertilizer trials on native pastures beginning in 1928 and well distributed over the state so as to represent a number of the more important soil types. It was found that application of 500 pounds per acre of a fertilizer relatively high in nitrogen (e.g. a 10-6-4 combination) brought about increases of approximately 100 per cent in yield. This increase was obtained principally during the months of May, June and July. Increased yield was accompanied by substantial increases in nitrogen content of the herbage and a consequent increase in nutritive value. (32 pp., 9 tables, 17 figs.)

Tech. Bul. 168.—A Study of the Protein-Nucleates of the Species of the Genus *Brucella*.—Stahl, W. H., Pennell, R. B. and Huddleson, I. F.—Methods are described for preparing *Brucella* protein-nucleate and separating it into its components, protein and nucleic acid. The protein-nucleate comprises approximately 14 per cent of the total dry weight of the cells in the case of the preparations from smooth strains, and about 18 per cent of the intermediate rough and rough strains. The

protein component comprises about 70 to 75 per cent of the protein-nucleate prepared from the smooth strains and about 60 per cent of those prepared from the intermediate rough and rough strains. The nitrogen partition is given. All proteins contain traces of sugars, but no amino-sugar.

Guanine, adenine and cytosine, but no thymine and uracil, were found in the nucleic acids. Both pentose and desoxypentose sugars were present and studied quantitatively. There was a soluble and insoluble portion when mixed with an excess of glacial acetic acid, and further data tend to show that there are two nucleic acids present; the other alternative, a nucleic acid composed of both pentose and desoxypentose nucleotides, is possible but improbable.

The results of precipitation studies with the protein-nucleates and protein components from smooth strain preparations show that they are not type-specific, and that the nucleic acid possesses no precipitating power. The protein-nucleate and protein component from the intermediate rough and rough strain reacted only slightly with homologous and heterologous antiserum. Their nucleic acids also possessed no precipitating power. The protein-nucleate and protein component elicit non type-specific reactions in *Brucella* sensitized rabbits. The IR and R strain preparations elicit only a slight allergic reaction. The protein-nucleate, protein and nucleic acid were found to be non-toxic. (22 pp., 10 tables.)

JOURNAL ARTICLE ABSTRACTS

Photosynthetic Studies of Mutational Barrenness in the Montmorency Cherry.—Crist, J. W.—*Jour. Agr. Res.* 59 (7): 547-553. 1939. (Journal Article No. 233, n. s., from the Michigan Agricultural Experiment Station.)—Buds from a mutating barren branch of a Montmorency cherry tree were propagated and trees therefrom produced. The result was that of some normal trees, some wholly barren, and some a mixture of these two characteristics.

A test was made on these trees of the hypothesis that the failure of the barren portion to form fruit buds was due to a relatively low rate of photosynthetic activity and hence insufficient storage of organic materials in the spurs prior to and during fruit-bud initiation and development. Two seasons of experimental observations using the Sach's half-leaf method for determining photosynthetic rates showed this to be the case. The evidence of the rates themselves was supplemented and affirmed by data obtained from successive analyses of the chemical composition of the spurs.

Variation and Correlation in Bud Mutants of the Montmorency Cherry.—Crist, J. W.—*Jour. Agr. Res.* 59 (5): 393-395. 1939. (Journal Article No. 334, n. s., from the Michigan Agricultural Experiment Station.)—Measurements of areas of individual leaves of a bud mutant of the Montmorency cherry were compared with similar measurements for the parent form. There was some indication of a greater degree of variability in the mutant than in the normal form.

Squab Chickens—An Outlet for Excess Cockerels.—Schaible, P. J., Ruth M. Griswold, J. A. Davidson, and Selma L. Bandemer.—Proceedings of the Seventh World's Poultry Congress, pp. 448-452. 1939. (Journal Article No. 348, n. s., from the Michigan Agricultural Experiment Station.)—Surplus day-old cockerels may be economically grown to 1 to 1.25 pounds of live weight and marketed as squab chicken when space, labor, equipment, or financial requirements do not permit their growth to heavier market classes of poultry. To produce equal live weights of broiler (12-week-old) and squab (6-week-old) chickens, 31.8 per cent less feed, 25.6 per cent less floor area, and 35.9 per cent less volume are required for the squab chickens. On the other hand, 2.5 times as much area would have to be heated for these birds. Despite a higher mortality rate of squab chickens than of broilers, the greater investment per casualty in the latter more than outweighs the loss of a larger number of less expensive squab chicks. Leghorns weighing 1 to 1.25 pounds are as satisfactory in body conformation as other breeds of the same weights. The marketing of Leghorn cockerels as squab chickens would result in uniformly higher quality in the heavier classes of poultry because this practice would result in Leghorns being sold at their best rather than allowing them to grow into older birds of poorer quality.

Of particular interest to hatcherymen is the fact that two to three times as many baby chicks would be required to produce the same weight of squab chickens now supplied by the heavier classes of poultry. Squab chickens, when served whole, are "eye-appealing", particularly suited for hotel and banquet service.

Methods of dressing and preparation for serving are described in detail.

Experimental Work on Lactic Acid in Preserving Pickles and Pickle Products.—Fabian, F. W. and C. K. Wadsworth.—Food Research 4: 499-529. 1939. (Journal Article No. 350, n. s., from the Michigan Agricultural Experiment Station.)—Previous studies at this station on genuine dill pickles and salt stock pickles had shown that in normal fermentation the ratio of lactic to acetic acid was 8:1 for dill pickles and 6:1 for salt stock pickles. These experiments were conducted to test the suitability of substituting lactic in whole or in part for acetic acid in the preservation of pickles. It was found that salt is removed at a much faster rate during the first than during the second 24-hour freshening period, approximately 50 per cent of the salt being removed during the first hour after heating. Acetic acid penetrates pickles more rapidly than lactic acid. The rate of penetration of acid into the pickles is greatest during the first 24 hours after they are placed in the acid liquor, 75 to 80 per cent of the total amount being absorbed by small pickles within the first six hours. Equilibrium is reached within 40 hours for small pickles.

Studies dealing with the preservative value of acetic and lactic acids in the presence of sucrose, made with an acid-tolerant yeast, show that when the acetic acid was kept constant and the concentration of sucrose was varied from 14° to 24° Baume for each series of experiments, there was a gradual decrease in the number of jars of pickles showing viable yeasts as the percentage of sugar was increased. When the amount of sucrose was kept constant and the percentage of acetic

acid increased, there was a gradual reduction in the number of jars showing viable yeasts. No significant reduction occurred, however, until a 22° Baume had been reached. Under the same conditions, increasing the lactic acid content did not effect nearly so great a reduction in the number of jars showing the viable yeasts—this despite the fact that the lactic acid solutions had a lower pH value. Likewise, increasing the sugar concentration in the presence of lactic acid did not reduce the number of jars showing viable yeasts nearly so much as did acetic acid.

In a similar series of experiments using a combination of acetic and lactic acids in the presence of varying amounts of sucrose, the preserving action was proportional to the amount of acetic acid used. The influence of increasing the concentration of sucrose on the viability of yeasts is not so great in a combination of the two acids as with acetic acid alone but greater than with lactic acid alone. An acidity of not less than 2 per cent acetic or a combination of acetic and lactic acids in the ratios used in these experiments is recommended for preserving pickles or pickle products.

Under the conditions of these experiments, pH was not found a reliable indicator of the preserving power of the acids present.

In experiments in which sweet pickles, process dill pickles and relish were made with acetic acid and combinations of acetic and lactic acids, it was found that lactic acid, when used alone or in combination with acetic acid, is not suitable for making sour pickles either from the standpoint of flavor or keeping properties. Lactic acid is not suitable for making sweet pickles or relish when used alone, but greatly improves the flavor of these products when used in the proper ratios with acetic acid. The best ratios were 1.6 : .4 or 1.8 : .2 per cent of acetic and lactic acids, respectively.

A combination of lactic and acetic acids gave better-flavored processed dill pickles than either acid alone. The ratio of acetic to lactic calculated as acetic, which gave the best results was 1 : .2, .8 : .4, or even as high as .6 : .6 per cent, respectively, with distilled vinegar.

A Comparison Between Yields Calculated from the Grain-Straw Ratio and Those Calculated from Small Cut-Out Areas.—Davis, J. F.—*Jour. Amer. Soc. Agron.* 31: 832-840. 1939. (Journal Article No. 352, n. s., from the Michigan Agricultural Experiment Station.)—Yields of oats plats calculated by taking the total bundle weight of the plat times the ratio of grain weight to the bundle weight of a small portion of the plat was found to agree more closely to the actual weight of grain obtained by threshing the entire plat than did yields estimated by the method commonly used of harvesting small areas from a plat with a hand sickle.

Comparisons between plat yields based on five, four, three, two, and one bundle selected at random from a plat and plat yields estimated from six, five, four, three, two and one area were made with the plat yields obtained from threshing the entire plat. A statistical examination of the data shows higher "r" and "Z" values and closer conformation on the regression line to the line $Y = X$ when yields secured from the weight relationship method of calculating yields are compared with the actual plat yields than when the yields are obtained from small areas cut from the plat by hand. The standard errors of estimate and

the errors of estimate from the line $Y = X$ varied significantly between all area methods and the method in which the weight relationship of five bundles to the total grain and straw weight of the entire plat was used.

Three bundles weighed from a plat 14' x 150' are sufficient to give a very accurate estimate of plat yields and would be the recommended number to use in yield estimation for a plat of this size. The amount of hand labor required is lessened considerably in the use of the weight relationship method since the entire plat is cut with a binder and at the same time; this method gives a better estimate of the actual plat yield than when the yields are based on areas cut out by hand.

A Chemical Study of Ketosis in a Dairy Herd.—Duncan, C. W., Huffman, C. F. and Tobin, H. A.—*Jour. Am. Vet. Med. Assoc.* *XCV* (753): 690-700. 1939. (Journal Article No. 355, n. s., from the Michigan Agricultural Experiment Station.)—Some constituents of the blood, urine and milk were determined in samples collected from a herd of purebred Jersey cows suffering from acetonemia. The disease had become so malignant that all of the milking cows, first-calf heifers, and open heifers were becoming affected. The ration consisted of poor quality soybean hay, corn silage, and a small amount of grain. The treatment consisted of changing the ration to alfalfa hay, corn stalks, larger portions of grain, and corn sugar or molasses, and the administration of chloral hydrate to the most severely affected cows. The condition was not entirely cleared up in some of the cows until after they were turned out to spring pasture.

The ketone bodies in the blood of the milking cows before treatment varied from 1.55 to 79.05 mg. per 100 cc. while the variation in the urinary ketone bodies was from 20.3 to 549.5 mg. Four weeks later these constituents had decreased to an average of 2.96 and 53.6 mg., respectively. The ketone bodies were also present in the milk in amounts from traces to 42.9 mg.

The values obtained for plasma calcium, magnesium and chloride did not indicate a disturbance in the metabolism of these constituents in ketosis. The subnormal inorganic phosphorus values were associated with the poor nutritional condition of the cows. Acidosis was not encountered in this investigation and a lack of relationship was found between the blood ketone bodies and the carbon dioxide combining capacity of the blood.

In light of recent investigations concerning the variety of hydrolytic cleavage products produced by bacterial and enzymatic fermentation of cellulosic materials, it is suggested that these intermediate products may play an important part in ruminant digestion and particularly in the study of the physiology of ketosis. The general conclusion is reached that certain practical measures can be taken to reduce the incidence of ketosis in farm herds under stall-feeding conditions. The most important of these are an improvement in the general management of the herd and better feeding, especially in regard to roughages. The results also suggest that high-producing cows on ordinary roughage rations may be demanding additional quickly soluble sugars to satisfy their demand for endogenous carbohydrate metabolism.

A New North American Species of *Asteia* (Diptera, Asteiidae).—Sabrosky, C. W.—*Pan Pacific Entomologist*, 15 (4): 165-167, 1 fig.

1939. (Journal Article No. 359, n. s., from the Michigan Agricultural Experiment Station.)—*Asteia multipunctata* Sabrosky, new species, is described and named. It belongs to a small and uncommon group of flies of which barely a half dozen species have hitherto been known from the United States.

Papillary Edema and Nyctalopia in Calves.—Moore, L. A.—Jour. Dairy Sci. 22 (10): 803-812. 1939. (Journal Article No. 360, n. s., from the Michigan Agricultural Experiment Station.)—Calves placed on low carotene rations at 40 to 90 days of age developed nyctalopia in from 48 to 73 days. Papillary edema developed at approximately the same time although there were some variations. An intake of about 9 micrograms of carotene per pound of body weight was not sufficient to prevent nyctalopia or an increase in papillary edema. An intake of about 16 micrograms per pound of body weight was sufficient to maintain the plasma carotene at 0.2 micrograms per ml. and above in Holstein and Ayrshire calves and to prevent nyctalopia and maintain fair general health. When the plasma carotene values fell below about 0.13 micrograms per ml., nyctalopia and papillary edema followed in Holstein and Ayrshire calves.

The carotene requirements given by Guilbert and Hart (7) for the bovine are approximately correct where nyctalopia is used for a criterion.

Cooked and Oxidized Flavors of Milk as Affected by Ferrous Iron.—Gould, I. A.—Jour. Dairy Sci. 22 (12): 1017-1023, 1939. (Journal Article No. 365, n. s., from the Michigan Agricultural Experiment Station.)—This study was conducted to determine: (a) the relation between the cooked and iron-induced oxidized flavors when the iron was added before and after heating the milk, and (b) the possible correlation of the findings with the liberation of the heat labile sulphides of the milk. The results showed a definite relationship between the cooked and oxidized flavors in milk to which had been added 2.8 p.p.m. ferrous iron either before or after the heat treatment. The critical temperature was approximately 80° C., i.e. the milk heated to lower temperatures failed to show the cooked flavor after 48 hours but had developed the oxidized flavor, whereas the milk heated to higher temperatures possessed a persistent cooked flavor and did not become oxidized. Ferrous iron was found to have only a negligible influence on the persistence of the cooked flavor in contrast to a pronounced influence exerted by copper. The liberation of volatile sulphides was greatly retarded by copper, whereas the ferrous iron showed only a slight influence in this connection. The differences between copper and ferrous iron in influencing the cooked flavor of milk may be due to differences in the sulphide-combining abilities of these metals, due to differences in their abilities to form complexes with the substance supplying this heat-labile sulphur, or due to differences in their oxidizing properties.

The Use of Brilliant Green, Sodium Azide, and Dextrose in the Microscopic and Hotis Tests for Streptococcic Mastitis.—Bryan, C. S., Devereux, E. D., Herschey, W. C. and Corbett, A. C.—The North American Veterinarian. 20 (9): 41-46. 1939. (Journal Article No. 370, n. s., from the Michigan Agricultural Experiment Station.)—The use of a selective preservative yielding a final dilution of 1:50,000 brilliant green,

1:15,000 of sodium azide, and 1:1,000 of dextrose in the milk increased the accuracy of results of the microscopic test as compared to the use of brilliant green alone as the preservative and greatly reduced the time required to read the results by suppressing both the udder micrococci and contaminating bacteria.

The use of the same selective preservative in the Hotis test increased the 24-hour reading from 60 per cent efficiency to 81 per cent efficiency and reduced the number of negative cows giving positive results from 7.3 per cent to 2.6 per cent. The 48-hour reading increased the efficiency of the testing of infected cows from 68 per cent for the regular Hotis test to 87.6 per cent and reduced the number of negative cows giving positive reactions from 14.6 per cent for the regular Hotis test to 4.6 per cent.

Effect of Sulfapyridine (Dagenan) on *Brucella abortus* in vitro and in vivo.—Hamann, E. E. and Huddleson, I. F.—Proc. Soc. Exp. Biol. and Med. 42: 555-556. 1939. (Journal Article No. 372, n. s., from the Michigan Agricultural Experiment Station.)—The oral administration of sulfapyridine to guinea pigs in amounts varying from 3.4 to 100 mg. over a period of ten days had little, if any, effect on the course of *Brucella* infection. The results of *in vivo* experiments show that sulfapyridine has a definite bacteriostatic action on *Brucella abortus*. The decrease in the number of organisms is especially noticeable after five days incubation in broth in the presence of sulfapyridine in a 1:1,000 and 1:10,000 dilution.

Isolation of Phytopathogenic Actinomycetes.—KenKnight, G. and J. H. Muncie.—Phytopath. 29: 1000-1001. 1939. (Journal Article No. 375, n. s., from the Michigan Agricultural Experiment Station.)—A simplified method of isolating Actinomycetes from potato scab lesions is described with formulae of suitable culture media for separation of Actinomycetes from secondary organisms and contaminants.

Information Obtained by the Microscopic Examination of Raw Milk Not Shown by the Methylene Blue Test or the Standard Plate Count.—Fox, W. K., Turney, G. J., and Bryan, C. S.—The Milk Dealer, 28 (12): 42. 1939. (Journal Article No. 376, n. s., from the Michigan Agricultural Experiment Station.)—The microscopic clump count and the (old) standard plate count compare very favorably when used on producer samples of raw milk to determine the bacterial count of raw milk. The microscopic method presents not only a method of counting, but also a means of determining the causes of poor quality in high count milk. The types of bacteria present indicate the probable source of excess contamination in the system of milk production. This information facilitates more effective field work in a quality control program. The amount of visible dirt in milk as shown by sediment tests has very little bearing upon the bacteria count of the milk.

Experimental Work on Processing and Finishing Pickles, II. The Correct Use of the Salometer in Pickle Manufacture.—Richardson, D. E., Fabian, F. W. and Wadsworth, C. K.—Fruit Products Journal, 19: 75-77. 1939. (Journal Article No. 388, n. s., from the Michigan Agricultural Experiment Station.)—A study was made of salometers used in the pickle industry. It was found that the per cent error of reading of the salometer ranged from 3.3 to as high as 23.3. In some types of

pickles such as genuine dills, this would account for some of the heretofore unexplainable losses due to spoilage.

The results showed that the salometer reading is accurate as an index of salt content only in high salt concentration such as found in salt stock or similar strong brines. It is desirable to determine the salt content of weaker brines such as used in genuine and process dills, and in freshening and processing waters by titration with silver nitrate and to convert it to the true salometer value by a conversion curve. A correction must be applied for the density of volumetrically measured samples and may be most conveniently applied by incorporating it in the conversion curve. This correction may be neglected in samples testing less than three per cent salt. Sufficiently accurate results may be obtained in determining the salt content of sweet liquors by neglecting the conversion correction and taking the per cent salt by titration. The accuracy and simplicity of the method outlined recommends it for use in plant practice.

The Preparation and Purification of *Brucella* Antiserum.—Huddleson, I. F. and Pennell, R. B.—*Science*, 90: 571. 1939. (Journal Article No. 396, n. s., from the Michigan Agricultural Experiment Station.)—A purified specific precipitating and toxin neutralizing antiserum for *Brucella* has been prepared by making use of $AlCl_3$ and pepsin for removing 97 per cent of non-antibody protein.

The purified antiserum is precipitated by the soluble toxic fraction from *Brucella* cells when the fraction is diluted to 1:4,000,000. When an amount as small as 0.000156 cc. is injected into a guinea pig one hour before the injection of a toxic dose of the soluble toxin, the guinea pig is completely protected from a toxic reaction and death.

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- C104 Clothes-Moths and Carpet Beetles
- C107 The Mexican Bean Beetle
- C132 June Beetles or White Grubs in Michigan
- C133 Soft Scales Injurious to Deciduous Ornamentals
- C134 Wood Boring Insects which Attack Furniture and Buildings
- C141 Some Chewing Insects Infesting Michigan Evergreens
- C144 Flies and Mosquitoes Commonly Found About Michigan Homes
- S83 Key to Orthoptera of Michigan
- S204 Investigations of Corn Borer Control at Monroe, Michigan
- S214 Insects Affecting Ornamentals Under Glass
- S221 Controlling the Codling Moth in Southwestern Michigan
- S230 Success and Failure of Spraying for Scab and Codling Moth
- S234 Spraying and Dusting Potatoes in Michigan
- S238 Some Wood Borers Attacking the Trunks and Limbs of Deciduous Trees and Shrubs
- S239 The Principal Grape Insects in Michigan
- S243 Important Leaf Feeding and Gall Making Insects Infesting Michigan's Deciduous Trees and Shrubs
- S244 Insect Pests of Stone Fruits in Michigan
- S266 Dahlias: Their History, Classification, Culture, Insects and Diseases
- S277 Insecticide Experiments on Codling Moth in Michigan, 1929-1935
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- EE154 Supplement to Spraying Calendar No. E154, which is temporarily out of print
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- E198 Controlling Plant Lice on Field and Garden Crops

FARM MANAGEMENT

(See Agricultural Economics)

FERTILIZERS (See Soils)**FLORICULTURE**

(See Landscaping and Plantings)

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- S190 Oak Forests of Northern Michigan
- S196 The Farm Woodlot in Michigan
- E147 Forest Planting on Michigan Farms (Also see 4-H Club Bulletins)

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- C98 How to Make, Clarify and Preserve Cider
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(For Control of Household Insects, see Entomology)

HORTICULTURE

(Apples, Berries, Grapes, Melons, Vegetables, Bees)

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- C130 Cultural Method of the Bearing Vineyard
- C143 Construction and Management of Air-cooled and Cold Storages with Special Reference to Apples
- C146 Three Virus Diseases of the Peach in Michigan
- C152 Raspberry Growing in Michigan
- C155 Selection of Orchard Sites in Southern Michigan
- C160 Protecting Cherries from Birds
- C162 Control of Soil Erosion in Michigan Orchards
- C163 Annual Cover Crops for Michigan Orchards
- C166 Water Conditioning for Greenhouses
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- S271 The Katahdin Potato in Michigan
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- S288 Marketing Potatoes in Michigan
- S290 Tomato Varieties
- *E4 The Home Vegetable Garden
- E83 Growing Peas for the Canning Factory
- E130 Small Sash House for Growing Vegetable Plants
- E156 Tomato Growing in Michigan
- E158 Timely Tomato Topics
- E162 Michigan Potato Diseases and Their Control
- E200 Controlling Vegetable Diseases in Seed-bed and Coldframe

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(Flowers, Trees and Ornamentals)

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- C156 Management of Bent Grass Lawns
- S222 Garden Roses
- S228 The Rock Garden
- SS228 Supplement—Lists of Rock Garden Plants
- S266 Dahlias, Their History, Classification, Culture, Insects and Diseases
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- E166 Ant Control in Houses and on Lawns
- E175 Control of Sucking Insects on Conifers
- E178 Evergreens
- E199 Landscaping the Home Grounds

(For additional references on Insects affecting Ornamentals, see Entomology)

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- S178 Michigan Raspberry Diseases
- S213 Oat Varieties and Diseases in Upper Peninsula

- S234 Spraying and Dusting Potatoes in Michigan
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 E176 Oat Smut Control
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POULTRY

- E51 Feeding for Egg Production
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**CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION**

IMPROVING THE HAY CROP OF THE UPPER PENINSULA

B. R. CHURCHILL
SECTION OF FARM CROPS

Tame hay is by far the largest crop of the Upper Peninsula, occupying 53.2 per cent of the land available for crops, according to the 1935 agricultural census. The relation of this crop to the acreage of other crops of the peninsula is shown in Fig. 1.

Nine counties in 1934 had more than 50 per cent of their available crop land in hay. Several factors have influenced the acreage devoted to this crop; however, there are two major ones. With the small acreage available for crops per farm it has seemed a wise policy to grow

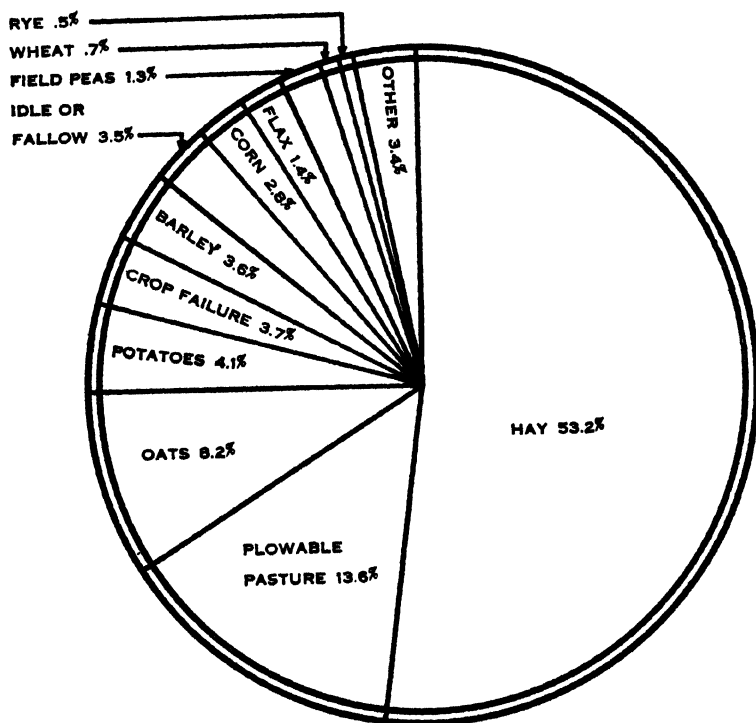


Fig. 1. Percentage of land used for various crops in relation to the total acreage available for crops in the Upper Peninsula, according to the 1935 agricultural census.

as much of the required roughage as possible and to buy the concentrates necessary for the livestock on the farms. Then too, in the "horse and buggy" days, the hay of the Upper Peninsula, especially Chippewa County, found a ready market in Chicago. Hay was the biggest cash crop of the region. The advent of the motor truck destroyed this market with the result that farmers of the Upper Peninsula found they had too much of the wrong kind of hay. Only 4 per cent of the hay acreage in 1934 was alfalfa. The acreage of this crop has increased considerably since then; however, the rate of change has been slow. Red and alsike clover were usually seeded with timothy, but fields have been left in hay long after the clovers disappeared.

Because of the foregoing situation, investigations were made at the Upper Peninsula Agricultural Experiment Sub-station to determine if possible, methods of improving the hay crop. In 1929, a mixture of red and alsike clover was seeded with timothy, the latter varying from 5 to 50 per cent of the mixture by weight. In 1930 similar seedings were made, using alfalfa instead of clovers. In 1933 seedings were made with alfalfa-timothy mixtures, the timothy varying from 1 to 10 per cent. In all tests no appreciable difference could be observed between the seedings containing the low and high percentages of timothy in the mixture. The stand of legume was at least fair in every case and the timothy was never very thick, all of which indicated that more than one pound of timothy per acre was a waste of seed provided 9 pounds of legume was also seeded and that a fair stand of the latter resulted. Timothy grown in a mixture with alfalfa was taller, leafier, darker green in color and contained a higher percentage of protein. Following those investigations, a mixture of alfalfa and timothy, the latter never constituting more than 10 per cent by weight, was recommended. Such a mixture was used on the station farm and proved satisfactory.

Repeated observations at the sub-station indicated that one year from date of seeding, the number of plants per square foot represented approximately one-fourth of the possible number based on the amount of seed planted. Rates of seeding and stand counts were therefore

Table 1. Effect of rate of seeding upon stand and yield of alfalfa, alfalfa-timothy mixtures and red and alsike clover mixtures.

Crop mixture	Rate of seeding Pounds per acre	Number of plants per sq. ft.	Per cent plants of seed planted	Yield 1 cutting Pounds per acre dry weight
Alfalfa.....	4	3.3	17.2	4,505
Alfalfa.....	6	4.0	13.7	4,430
Alfalfa.....	8	5.1	13.2	4,440
Alfalfa.....	10	5.5	11.3	4,266
Alfalfa-timothy mixture.....	4	2.8-1.1	15.6-20.8	4,959
Alfalfa-timothy mixture.....	6	3.2-1.2	11.9-15.0	5,106
Alfalfa-timothy mixture.....	8	3.6-1.3	9.9-13.0	4,786
Alfalfa-timothy mixture.....	10	4.4-1.3	9.6-10.4	5,093
Red and alsike clover mixture.....	4	4.0	10.7	2,442
Red and alsike clover mixture.....	6	5.8	10.6	2,945
Red and alsike clover mixture.....	8	6.2	8.3	2,904
Red and alsike clover mixture.....	10	6.2	6.7	3,222
Red and alsike clover mixture.....	12	6.9	6.2	2,905

made with alfalfa, and mixtures of alfalfa-timothy, red and alsike clover. A summary of these data, representing 9 crop years from 4 separate plantings, is given in Table 1.

When alfalfa or alfalfa-timothy mixed were seeded at rates varying from 4 to 10 pounds per acre the yield was not significantly changed. Rates of seeding varying from 6 to 12 pounds per acre did not materially change the yield of clovers. Four pounds per acre of the clover mixture in these trials was too low for maximum yields. Excluding that rate, the yield of clovers was 32 per cent lower than alfalfa while the alfalfa-timothy mixture was 13 per cent higher.

Stands improved as the rate of seeding was increased, although not in the same proportion. The higher the rate of seeding, the lower the percentage of plants in relation to seed planted. The number of plants per square foot had no influence on yield within the limits of the experiments.

Less than 20 per cent of the seed planted made plants which were available for harvest the following year. This large loss of seed offered a lead to further experimental work which might reveal why so many of the seeds failed to make plants. Field observations on the station farm indicated that on a loose seedbed the drill sank into the soil enough to bury the seed too deep even though the drill was set shallow and the seed was presumably seeded on the surface. To determine the effect of deep planting upon subsequent stand of alfalfa, seedings were made in triplicate of small plots in the spring of 1938 and in the fall of 1939. A summary of the results of these tests is given in Table 2.

Table 2. Effect of depth of planting upon subsequent stand of alfalfa at the Upper Peninsula Sub-station.

	Rolled, seeded, raked, rolled	Rolled, seeded 1½" deep, rolled
Rate of seeding; lb. per acre	10.8	10.8
Average number plants per sq. ft. emerged	24.1	4.5
Average number plants per sq. ft. after 90 days	23.9	2.9
Per cent of plants emerged, living after 90 days	99.1	64.4
Per cent plants (after 90 days) of seed planted	44.3	5.4

Deep planting as reported in Table 2 resulted in much poorer stands. Far more plants emerged from the shallow planting and practically all of those that emerged were still living at the end of 90 days. Only a small percentage of plants emerged in the deep-planted plots and more than one-third of these died within 90 days, which indicated their weak condition at date of emergence. These results indicate further that deep planting may be a major cause of poor stands of alfalfa in many instances throughout the Upper Peninsula. Planting too deeply on a field scale is usually the result of a loose seedbed. The most efficient method of firming the seedbed is to roll or cultipack the ground just previous to seeding.

Frequently the price of some particular seed is unusually high and the natural tendency is to use a substitute, either entirely or in a mixture. To test the possibilities of such a procedure, a series of plots

Table 3. Summary of yields of hay mixtures at the Upper Peninsula Experiment Sub-station—1937 and 1938.

Crop or mixture and rate in lb. per acre	Average yield: lb. per acre dry weight
Alfalfa 8 lb., alsike clover 2 lb., smooth brome 5 lb.	5,566
Alfalfa 4 lb., alsike clover 4 lb., timothy 1 lb.	5,287
Alfalfa 4 lb., alsike clover 4 lb., smooth brome 5 lb.	5,170
Alsike clover 5 lb., smooth brome 5 lb.	5,169
Alfalfa 8 lb., alsike clover 2 lb., timothy 1 lb.	4,946
Red clover 7 lb., alsike clover 3 lb., timothy 1 lb.	4,762
Alsike clover 5 lb., timothy 1 lb.	4,698
Alfalfa 8 lb.	4,506
Red clover 4 lb., alsike clover 4 lb., timothy 1 lb.	4,497
Red clover 10 lb.	3,629
Red clover 7 lb., alsike clover 3 lb.	3,595
Alsike clover 6 lb.	3,528

were seeded at the station in 1937, 1938, and 1939. Yields from the first two years of the test are summarized in Table 3.

Tests show that mixtures as a whole produce more roughage than a one species crop. This corroborates the data on mixtures given in Table 1. The average production of all mixtures was 4,854 pounds while the one species crops averaged 3,888 pounds per acre. Alfalfa yielded considerably more than red or alsike clover. Smooth brome grass mixtures averaged 325 pounds per acre more roughage than mixtures containing timothy. Alfalfa was superior to red clover in mixtures; however, yields of the latter were satisfactory. Individual crops can apparently be added to the mixture at different rates without changing the yields to any great extent. The results indicate that if any one crop seed is unusually high-priced it can be reduced or even omitted from the mixture. One should, however, keep in mind the number of years the crop is to be harvested. The above data were for the first crop only for red clover, and red and alsike mixture while all other data were taken from the first and second crop years. If a field is to be left longer than two years alfalfa has a distinct advantage over either red or alsike clover.

The thousands of acres already in grass meadow in the Upper Peninsula probably cannot be improved through cultural practices of seeding mixtures. However, they can be improved by the use of commercial fertilizer and cutting at the proper stage of growth. At the sub-station a quack grass meadow was fertilized with ammonium sulphate in early spring at the rates of 250, 500 and 1,000 pounds per acre. The hay was cut a few days after the first heads appeared. Results of the tests for 1937 and 1938 are given in Fig. 2.

Both total yield and protein were increased by the application of ammonium sulphate and, within the limits of the experiment, the more fertilizer used the higher the yield of both total hay and protein. It should be noted that the high yield of protein resulted from a combination of early cutting and the use of commercial fertilizer. The ammonium sulphate at \$2 per cwt. at 250 pounds per acre produced the protein $1\frac{1}{2}$ cents per pound cheaper than it could be purchased in the form of soybean meal and in addition, more than doubled the total yield of hay. These results corroborate the data reported by S. T.

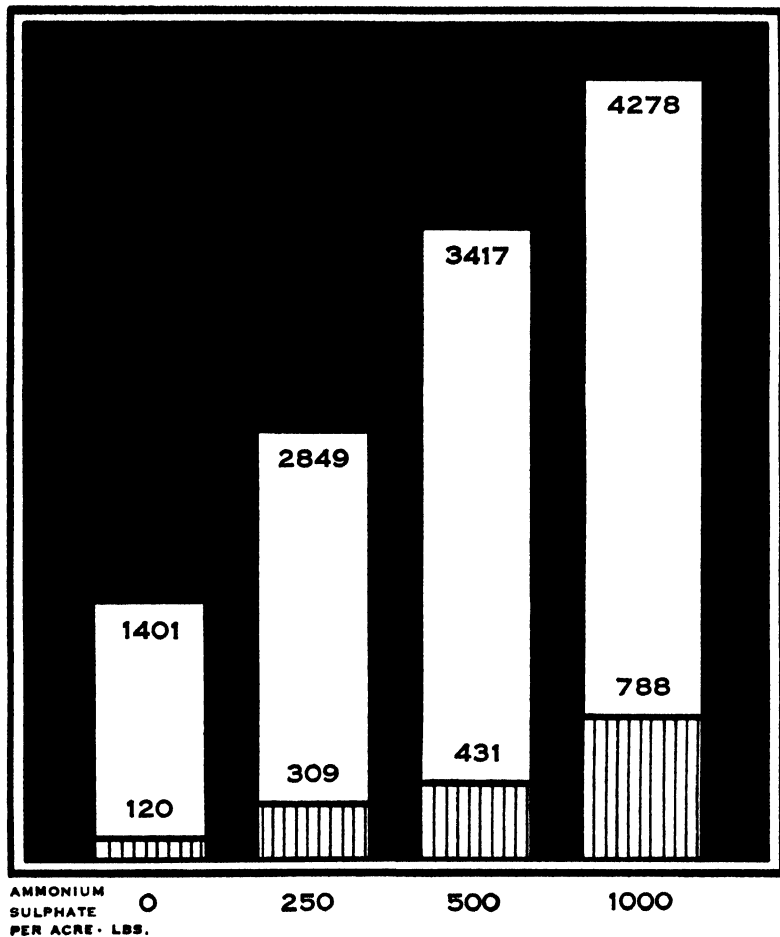


Fig. 2. Effect of ammonium sulphate upon total yield and yield of protein per acre in pounds upon quack grass at the Upper Peninsula Agricultural Experiment Sub-station—1937 and 1938 acreage.

Dexter and D. I. Clanahan in Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 21, No. 3, pp. 176-179.

Summary and Recommendations

Data are presented to show the hay situation as it exists in the Upper Peninsula. Results of experiments with rates of seedings, mixtures, depth of planting, and the use of ammonium sulphate on grass meadows are reported. Rate of seeding as a factor in improving hay stands was of less importance than choice of variety, lime, inoculation, seedbed preparation and depth of planting. Planting too deeply undoubtedly causes many seeding failures throughout the Upper Peninsula.

On soils abundantly supplied with lime or those which have in the past produced excellent stands of alfalfa, this crop is recommended.

On soils with a pH of 6.0 or below, a mixture would probably be the proper choice, especially if such soils have not grown alfalfa before. For most soils the mixture should contain alfalfa. Although as little as 4 pounds of seed per acre gave good yields in the experiments reported, a rate of 8 pounds per acre is recommended for general conditions. A much higher quality hay results when cut at an earlier stage of growth. Most of the hay of the Upper Peninsula is cut at a stage of growth too ripe for good quality. Hay fields are left unplowed for too many years. They should be broken up after a few years and kept in the regular rotation. Grass meadows now being used for hay can be made much more productive by the proper use of fertilizer.

SOME OBSERVATIONS ON ARTIFICIAL BREEDING

RUSSELL E. HORWOOD, C. L. COLE AND E. S. SMILEY
SECTIONS OF DAIRY AND ANIMAL HUSBANDRY

During the past two years much interest has developed in the subject of artificial breeding of dairy cattle. The widespread use of this practice has developed on somewhat limited experience in the United States. Plans or procedures for artificial breeding may be arbitrarily resolved into three classes. One plan contemplates the operation of a cooperative breeding circuit; another involves the private ownership of a bull with his services being made available to such breeders as desire. The third plan involves only one herd where artificial breeding instead of natural service is used.

Of these the cooperative plan appears to be the most desirable one where semen is to be distributed widely and the one most commonly in use throughout the United States. Under this plan members are organized into a cooperative association. The association owns or controls the bulls. The breeding is carried on by a trained technician employed by the association. For this plan of breeding to succeed the territory must be limited to possibly a 15-mile radius, a minimum of 1,000 cows should be signed up for the most efficient operation of the organization; a full-time, trained technician should be placed in charge of the work and well-selected sires, preferably outstanding proved bulls, used. Limited experience with this plan of artificial breeding in several states indicates that where these requirements are met, a breeding efficiency comparable to natural breeding can be obtained. The use of meritorious bulls can be widely extended. Young sires can be evaluated earlier in life and with less risk per herd, provided they are used in conjunction with a testing program. Also, the danger and inconvenience of keeping many bulls can be eliminated. This plan is generally acceptable by the national breed associations where these requirements have been attained.

The plan whereby the owner of a bull distributes the semen is much easier to develop, but may have many handicaps. The operator in many cases will not be properly trained in the technique of obtaining, preserving, and using semen. He may also lack the qualifications for mak-

ing examinations for pregnancy, diagnosing and treating diseased or abnormal cows. Information on sanitation and its importance in preventing the spread of disease is also essential. The lack of these qualifications on the part of the operator may jeopardize the dairy industry of the community. The quality of the bulls used in many instances will be inferior. Some national breed associations have already questioned this plan of breeding from the standpoint of accuracy in registering animals and it is expected that strict regulations may be put into effect to control it. Where the owner of the sires is distributing semen and is to profit directly by the volume of business many of these abuses will arise.

The third plan, breeding within a herd, has been carried on in the Michigan State College dairy herd during the last two years. This plan has been approved by national breed associations. It will be an aid in extending the life of valuable sires, especially if the preservation of semen proves successful. The services of bulls incapable of natural mating may be obtained. This was true in the case of one proved bull in the college herd. In some instances, artificial insemination may be used to control or prevent the spread of disease such as trichomoniasis. In fact, artificial breeding was started Aug. 1, 1938 in the college herd when there appeared to be some indication of this disease, although further evidence on the disease has been lacking.

Since this plan has been in operation, one proved bull has been injured so he could not be used for further breeding. This apparently was due to the use of the artificial vagina. Of the five old sires in service at the present time three are reluctant to breed artificially. Therefore, it has been necessary to mate some animals by natural service.

The time normally required for artificial breeding is double that of natural mating unless several animals can be bred from one collection of semen. If the new methods of preserving semen prove successful much of this can be eliminated. Artificial breeding on the other hand has been a convenience in the case of breeding heifers in pasture located at some distance from the herd sires. Special equipment and material are required. The technique for the use and care of this equipment must be developed to avoid injury to both male and female and to prevent the spread of infection and disease.

A summary of the first year's work shows that 2.94 services per conception were required. During the previous year with natural mating there was one conception per 2.92 services. This relatively low breeding efficiency is no doubt due largely to the use of old bulls. This same result might be expected in breeding associations where proved bulls are to be used.

Data were kept regarding breeding in relation to the heat period. It is of interest in that there were 101 services on the day the cows were observed in heat and also 101 services on the day following heat. From the 101 services on the day of heat, 49 conceptions resulted; from the other 101 services 26 conceptions resulted. Often animals in the first two plans of breeding outlined are bred the day following observed heat.

From the observations made in the college herd it appears that benefits which have been obtained through artificial breeding in the one herd about off-set the disadvantages that have been encountered.

EFFECTS OF FEEDING VARIOUS LOTS OF LEGUME GRASS SILAGE TO DAIRY CATTLE

A. R. SCHUBERT, B. R. CHURCHILL AND J. G. WELLS, JR.
SECTIONS OF DAIRY HUSBANDRY AND FARM CROPS, AND SUPERINTENDENT
UPPER PENINSULA SUB-STATION

The various methods employed in the making of grass and legume silages, and their feeding properties when fed to dairy cattle have received the attention of many investigators. Owing to the completeness of the recent "Review of Roughage Quality and Quantity in the Dairy Ration" by Huffman (1), literature citations will not be made here. This article gives the results of the various methods of preserving carotene in roughages through ensiling, and the appetizing value of various lots of grass-legume silage fed to the dairy cow. The present report was based on results of feeding the various lots of silages previously described (2).

Experimental

Nine head of Holsteins, three of which were cows and six yearling heifers, were divided into three groups (A, B and C) of one cow and two yearling heifers each, and used in a continuous feeding program. The breed, age, weight and calving dates are shown in Table 1. All cows and heifers were in good condition of flesh at the beginning of

Table 1. History of cows and heifers on experiment.

Group A				
No. of animal	Age		Weight lb	Days since last calving
	Years	Months		
344	1	4	805	—
342	1	5	883	—
308	5	2	1,404	99
Group B				
346	1	3	751	—
339	1	9	858	—
327	3	3	1,268	17
Group C				
343	1	4	745	—
340	1	9	912	—
282	7	8	1,282	130

Table 2. Description of the various lots of silage used.

Lot No.	Treatment	Composition of silage as fed				
		Legumes* per cent	Moisture per cent	Protein** per cent	Carotene ***	pH
1...	¼-½ bloom. Ensiled immediately. No preservative.	36.1	63.2	12.5	16	4.76
2..	¼-½ bloom. Ensiled immediately 2% beet molasses	31.5	64.2	13.2	46	4.24
3..	¼-½ bloom wilted, 2% beet molasses	30.2	57.9	12.6	28	4.73
4...	¼-½ bloom ensiled immediately, 2% beet molasses, longer cut ...	28.2	69.0	12.1	39	4.51
5..	Late full bloom ensiled immediately, 2% beet molasses	65.2	66.5	16.0	52	4.26

*The remainder consisted of timothy.

**Calculated on dry basis.

***Micrograms per gram dry matter.

the experiment. Cows were selected after considering the stage of lactation, general condition, size and producing ability.

Animals in Group A were fed silage; those in Group B were fed a ration consisting of one-half hay and one-half silage on a dry weight basis; and those in Group C received all hay. All cows received con-

Table 3. Gain in weight of animals by 25-day periods.

Animal No.	Initial Weight	Average daily gain in weight				
		Period 1 lb.	Period 2 lb.	Period 3 lb.	Period 4 lb.	Period 5 lb.
All silage						
Group A						
Heifer 344	805	.93	2.00	1.46	2.93	1.29
Heifer 342	883	2.64	1.96	1.11	1.50	1.14
Average	844	1.79	1.98	1.29	2.22	1.22
Cow 308.	1,404	.14	.54	.86	2.68	-1.50
Half silage and half hay						
Group B						
Heifer 346	751	1.79	1.14	2.11	1.39	.96
Heifer 339	858	2.54	1.07	1.82	.54	.64
Average	805	2.17	1.11	1.97	.97	.80
Cow 327.	1,268	-1.14	-.07	0	1.21	-1.21
All hay						
Group C						
Heifer 343	745	1.11	1.71	1.75	1.07	.32
Heifer 340	912	1.36	1.00	1.46	1.00	.93
Average	829	1.24	1.36	1.61	1.04	.63
Cow 282.	1,282	.61	-.79	.29	.96	-.11

concentrates in accordance with their milk production, namely, one pound of concentrate for each 2.5 pounds of milk produced over 20 pounds of milk per day. Heifers received 5 pounds of concentrate daily.

Hay samples were taken three times during each feeding period, and a composite sample made therefrom. Silage was sampled once each feeding period. Hence, five analyses each of the hay and the silage were made. These results are shown in Table 2.

Table 3 gives the initial weights and average daily gain or loss by periods of all animals on experiment according to the different roughages fed. Although the weights of cows did not vary appreciably, the cow on "all silage" made the greatest gain.

Noticeable differences in gains in body weight were observed in the case of the heifers. The two heifers on "all silage" consumed 145.4 pounds dry matter and made an average daily gain of 1.86 pounds; those on half hay and half silage on a dry weight basis consumed 155.8

Table 4. A comparison of the dry matter consumption of animals when fed silage alone, silage and hay, and hay alone.

Lot No	Fed lb		Consumed lb.		Fed lb.		Consumed lb	
	All silage							
	Heifer 344				Heifer 342			
1	16 49		14 93		16 49		14 09	
2	18 25		16 58		18 25		16 11	
3	16 30		15 29		16 30		15 93	
4	15 79		15 03		15 79		15 35	
5	12 03		10 96		12 03		11 11	
Lot No.	All hay							
	Heifer 343				Heifer 340			
	Hay lb.		Silage lb.		Hay lb.		Silage lb.	
1	16 51		15 43		16 51		16 31	
2	16 46		15 94		16 46		15 64	
3	16 11		15 57		16 11		15 61	
4	16 37		16 08		16 37		15 65	
5	16 48		16 15		16 48		16 33	
Lot No.	Half hay and half silage							
	Hay lb.		Silage lb.		Hay lb.		Silage lb.	
	Heifer 346				Heifer 339			
1	8 25	8 26	7 63	7 91	8 25	8 26	8 17	7 70
2	8 23	9 12	7 74	9 09	8 23	9 12	8 09	8 57
3	8 05	8 23	8 02	7 56	8 05	8 23	7 94	8 23
4	8 18	7 01	7 89	7 44	8 18	7 91	8 18	7 88
5	8 24	6 01	8 20	5 81	8 24	6 01	8 09	5 56

pounds dry matter and made an average daily gain of 1.53 pounds; those on all hay consumed 158.7 pounds dry matter and made an average daily gain of 1.28 pounds. Only 207 pounds of hay were refused by the six animals receiving hay during the 128-day feeding trial although the hay was not of good quality. This would indicate that the animals were not on too heavy a feed.

The study of the dry matter consumption of the various lots of silage was based on the refusal by all animals of silage from the five lots. The results are shown in Table 4. All lots considered, there was a refusal of 3.5 per cent of the silage. Silage in each lot was refused by all animals in various degrees. However, when segregating the cows and heifers in this study it was observed that the two heifers on all silage refused 7.5 and 7.7 per cent, respectively, and when on half silage and half hay 0.3 per cent and 0.47 per cent each. The cow on all silage refused 0.15 per cent and the cow on half silage and half hay refused 0.3 per cent.

The hay fed throughout the trial averaged 5.4 micrograms and the silage 36.2 micrograms of carotene per gram of dry matter. A week before the end of each feeding period, milk from each cow in each group was separated, the cream pasteurized and churned, and the carotene determined. The carotene content of butterfat or butter made from the cow on all silage was 3.1, that from the cow on half hay and half silage 2.0, and that from the cow on all hay 2.2 micrograms per gram of butterfat. (L. A. Moore, Research Assistant in Dairy Husbandry, aided in making carotene determinations.)

Summary

1. The silo is a good place for storing of roughage since it is a means of preserving more of the protein and carotene and because silage can be made during weather conditions unfavorable to the making of good hays.
2. The replacement of hay with silage either in part or entirely did not produce any significant difference in body weights of the cows during feeding trial.
3. Heifers fed all silage made considerably greater gains than those fed half silage and half hay and much greater gains than those fed all hay of not too good a quality.
4. The animals cleaned up the roughage better when fed half of the dry matter in the form of silage.

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POLLINATION STUDIES WITH THE MICHIGAN STATE FORCING TOMATO

A. F. YEAGER
SECTION OF HORTICULTURE

There have been many well planned and well-executed experiments with methods of pollination on greenhouse tomatoes. Bouquet (1) reported that it pays to hand-pollinate. In his experiments, increased returns far exceeded labor costs. He recommended the emasculation method. Schneck (2) reported that the watch glass and the emasculation methods of pollination increased the size of the tomatoes over shaking 15 to 20 per cent, and the total yield from 20 to 23 per cent. Both investigators agreed on the desirability of the emasculation method of hand pollination. These experiments, however, used tomato varieties of standard sorts. In 1936 the Michigan Agricultural Experiment Station (3) introduced a variety, Michigan State Forcing, resulting from the work of H. L. Seaton. This variety came from a cross between Ailsa Craig which carried short styles and Marglobe which had large fruit, the object being the production of a large, desirable short styled variety, the theory being that this would be a better self-pollinating variety than was Marglobe or the other standard tomato varieties.

The Michigan State Forcing variety is now the most important forcing variety of tomatoes in Michigan. A visit to the forcing houses in the Grand Rapids section disclosed that few growers were practicing hand-pollination, but were, nevertheless, getting excellent crops of this variety. When well-informed growers do not practice a method such as emasculation when it should be profitable, the question arises as to whether the growers are not experiencing unnecessary reductions in yields.

In the spring of 1938 a block of Michigan State Forcing tomatoes was planted in the vegetable greenhouse at the Michigan Agricultural Experiment Station, to determine whether the plants required hand-pollination to produce satisfactory crops. The plants were divided into two lots, one of which was pollinated by shaking daily or every other day; the other was pollinated by hand, using the emasculation method. The plants were pollinated three times each week. To make sure that every blossom was satisfactorily pollinated while the pistil was receptive, the emasculated blossoms were pollinated a second time a half-day after the emasculation was done. Unfortunately the greenhouse proved to be infested with nematodes, resulting in such a variability in the plants that the test was not considered to be conclusive. However, the plants which were hand-pollinated did not produce any more fruit than those which were shaken and the fruit was not larger in size.

In 1939 the experiment was repeated with the same object in mind. The treatments were alternated in the row, that is, one plant was jarred, the next one hand-pollinated, the next one jarred, the next hand-

pollinated. Throughout the whole block, 60 plants were emasculated and hand-pollinated; 61 plants were pollinated only by the aid of jarring. The seed was sown January 13. The plants began ripening their crop May 20 and picking was continued until July 15. The average yield for the whole block was 9.7 pounds per plant, which would be considered satisfactory. The accompanying table gives the results of this experiment.

Table 1. The effect of pollination method on fruit production with Michigan State Forcing tomato.

	Hand-pollinated	Jarred	Difference
Number of plants in treatment	60	61	
Average production per plants (gms)	4,234	4,543	309 ± 167
Average weight per fruit (gms.)	122.4	123.2	.8
Average number fruits per plant.	34.6	36.9	2.3

The results of this experiment are too obvious to require comment. The average production of the jarred plants was slightly greater than those that were hand-pollinated. The fruit size was also larger and the average number of fruits per plant greater where the plants were jarred rather than hand-pollinated, though these differences were in no case significant. It would seem therefore that for the spring crop with the Michigan State Forcing variety, which has a short pistil, the jarring method of pollination is just as satisfactory as the emasculation method.

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MID-SUMMER SPRAYS WITH LEAD ARSENATE TO CONTROL THE HICKORY BARK BEETLE

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The present outbreak of the hickory bark beetle, *Scolytus quadrispinosus*, has afforded an opportunity to experiment with arsenical sprays in an effort to kill the bark beetles before they established themselves under the bark. Since in mid-summer the newly emerged brood of hickory bark beetles feed for a time either on the terminal growths or at the base of the leaves before entering the bark, control efforts were directed against the beetles in that stage of their development.

Periodic losses from the hickory bark beetle are common in hickory stands in all parts of the United States east of the Mississippi River. Epidemic outbreaks are restricted to mature stands, the beetle population building up in undue numbers until all mature trees have been killed. The hickory bark beetle breeds only in hickory, but all varieties of hickory are attacked. The adults also feed on walnut and pecan, though the breeding tunnels have never been found under the bark of any host tree except hickory. The adults enter the bark under a bark flake or at a lenticel. The vertical egg galleries are excavated between the bark and the wood, following the grain of the wood. They vary in length from one to three inches. The larval mines are at first extended at right angles to the brood chamber, but gradually curve up or down, following the grain of the wood.

The hickory bark beetle has two annual generations in Michigan. Adults of the first generation emerge from their pupal cells about the third week in June. At this time the bark beetles feed for 3-5 days before they enter the bark. The result of their feeding is conspicuous in that quantities of fallen leaves accumulate under the trees. The feeding on the terminal growth is difficult to detect, but the feeding at the bases of the leaves either kills the leaves or causes them to drop. The fallen leaves are indicative of the feeding activities of the beetles, the degree of infestation and the relative size of the outbreak. The timing of the first spray can best be determined by the fallen leaves.

Spraying was started in mid-summer of 1937, and the first spray was applied, taking particular precautions to cover the terminal growth and the foliage; also the spray was shot upward under the bark to inject a coat of poison to check any surviving beetles before they would be able to build brood tunnels. The second application followed about six weeks later. In the second application the effort was confined solely to injecting the spray under the bark, hoping to penetrate any established egg tunnels.

The experiments were conducted in an isolated natural grove of mature shagbark hickory. All trees were more than 75 years old and were in prime condition for bark beetle attack, both from the standpoint of maturity and reduced vigor owing to prolonged drouth. The stand was ideal for experimental work since the beetles had been active in the grove for three or four years and up to 1936 a dozen or more trees, killed by bark beetles, had been removed from the planting.

The stand was separated into two plots. The only difference in the application was in the type of sticker-spreader employed. One plot was sprayed with lead arsenate using 4 pounds to each 100 gallons of water, plus 1 gallon of summer oil (Orthol K.). The second plot was sprayed with lead arsenate, using 4 pounds to each 100 gallons of water, plus $\frac{1}{2}$ gallon Petrocide, (a western dynamite type sticker). The sprays* were applied with painstaking care at about 600 pounds pressure and a delivery of about 20 gallons per minute. The first application was made June 19, and the second Aug. 11, 1937. Checks were made in September 1937 for any evidence of spray injury or any indication of bark beetle activities. The foliage appeared normal and no insects were found. The stand was checked from time to time throughout the growing seasons of 1938 and 1939 and no bark beetle injury

*Sprays were applied by graduate assistants, F. T. Parmelee and H. Milliron.

was detected. There was no apparent difference in the efficiency of the two sticker-spreaders used.

Apparently one thorough application of lead arsenate, 4 pounds in 100 gallons of water plus a sticker-spreader, is effective because timeliness is the important element in effecting control of this beetle with sprays.

INFLUENCE OF NEUTRALIZERS UPON THE CURD CONTENT OF BUTTER

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Although information is available dealing with the influence of neutralizers on many properties of cream and butter, practically no attention has been given to the possibility that, under certain conditions, neutralizers may influence the composition of the butter from the standpoint of the curd content. If neutralizers do affect the curd content of butter, such knowledge would be valuable to efficient butter-makers who are constantly striving to control accurately the composition of their butter.

The belief has been expressed that the use of lime neutralizers results in a higher curd content in the butter. This belief has not been fully substantiated. Bouska (2) found butter from cream neutralized with lime contained an average of 0.075 per cent calcium oxide, whereas butter from untreated cream showed an average of only 0.032 per cent. However, the data presented in this connection were variable and some of the untreated samples gave calcium oxide values as high as those given for the neutralized samples. The older textbook by McKay and Larsen (3) reports work in which the neutralization of cream to 0.25 per cent acidity with lime did not noticeably alter the lime content of the butter.

Because of the scarcity of information dealing with the influence of neutralizers on the composition of butter, composition data were obtained in connection with other studies which were being conducted on the neutralization of cream for buttermaking. These data are herein presented.

The butter used in this study was made from cream of approximately 35 per cent fat, which had been neutralized from approximately 0.50 per cent acidity to acidities of 0.25, 0.15, 0.10, 0.05 and 0.00 per cent with each of the following neutralizers: sodium carbonate, Recto, sodium hydroxide, Wyandotte C. A. S., calcium hydrate lime and magnesium oxide lime. At least three series were completed for each of these neutralizers.

Each individual sample of butter was obtained from a 200-pound lot of cream. The cream and butter were processed according to standard procedures.

All butter analyses were carefully conducted in duplicate, using the Kohman Method (1). Averages of the curd values are presented in Table 1.

Table 1. The influence of different neutralizers on the curd content of butter. (Ave. three trials)

Desired acidity	Neutralizer					
	Sodium carbonate	Recto	Sodium hydroxide	Wyandotte C. A. S.	Calcium lime	Magnesium lime
	Curd content of the butter					
per cent	per cent	per cent	per cent	per cent	per cent	per cent
0.25.....	0.74	0.76	0.91	0.83	0.69	0.82
0.15.....	0.77	1.02	0.88	0.89	1.03	0.94
0.10.....	0.93	0.82	0.91	0.97	1.20	0.84
0.05.....	0.83	0.83	0.99	0.85	1.34	0.99
0.00.....	0.82	0.86	0.88	1.03	1.31	0.88
Average.....	0.82	0.86	0.91	0.93	1.11	0.89

These results show that the curd content of butter varies to some extent regardless of the neutralizer used. However, these variations were not great and show no definite trend except in cream treated with calcium lime, in which case there was a progressive increase in curd content with increases in the reduction of the acidity of the cream. The curd content of butter from cream neutralized with calcium lime to a theoretical acidity of 0.25 per cent averaged 0.69 per cent, practically equal to the curd values of butter obtained when using any one of the other neutralizers. However, the curd content of the calcium lime butter increased to 1.03 per cent and to 1.31 per cent when the cream had been theoretically reduced to 0.15 and 0.00 per cent respectively. It was observed that a mealy body often occurred in the calcium lime butter when the cream had been reduced to a low acidity. This mealiness may be correlated with the changes in the curd content.

From the data obtained in this study, it would appear that the curd content of butter is not materially influenced by the kind of neutralizer added to cream nor by the point of acid reduction unless neutralized with calcium lime to a theoretical acidity of approximately 0.15 or below. The increase in the curd content of the calcium lime butter when the acidity desired was less than 0.25 per cent, amounted to 0.34 per cent at the 0.15 per cent acidity level, to 0.51 per cent at the 0.10 per cent level, to 0.65 per cent at the 0.05 per cent level, and to 0.62 per cent at the 0.0 per cent acidity range.

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AVAILABLE PLANT NUTRIENTS IN LAKE SOILS*

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In a classification of soils a wide range of conditions must necessarily be accommodated, particularly regarding moisture content. This range includes desert conditions on one extreme and swamp or marsh conditions on the other. In the latter group are embraced many soils which may be seasonally inundated and are at or near the saturation point during all seasons of the year. A complete classification should be still more inclusive so as to include those soils which are permanently inundated—occurring in lakes, ponds, and streams. Veatch (5) proposed an extension of the soil taxonomic system which included these lake soils and applied to them the term "hydrosol".

The study of hydrosols, however, is not only the concern of the soil taxonomist but it has attracted the interest of the group whose objectives are to study and manage the aquatic life in the lakes—particularly fish and the "higher" vegetation. The aquatic biologists, then, have recently given more attention to hydrosols in conjunction with their more comprehensive studies of the lakes throughout the country. In Michigan this work has been carried out by the Institute for Fisheries Research, the research branch of the Fish Division of the State Conservation Department. They have made, during the last several years, reconnaissance surveys of many lakes in all parts of the state, continuing and expanding the work previously suggested and initiated by the Land Economic Survey.

Because of the continued need for more intensive study of the lake soils and their relation to production of aquatic life, a special project for this study was established, with the Institute for Fisheries Research cooperating with the Soils Section of the Agricultural Experiment Station at Michigan State College through the Conservation Institute. This is a preliminary report, giving a summary of certain phases of the work. Final conclusions, together with the report of the entire study, will appear at a later date.

At the outset it was believed that the relationship between the hydrosols and plant growth might be largely a matter of plant nutrient relationships, to the same extent as it is in agricultural soils and possibly more so since some other factors, particularly moisture content, do not fluctuate so widely in hydrosols as in agricultural soils. Hence the nutrient content of hydrosols might assume proportionately greater importance. The purpose was, then, to determine the nature and extent of the nutrient supply and the way in which differences in nutrient content are reflected by the nature and luxuriance of the plant associations.

*Material in this article constitutes a part of a thesis to be submitted to the Graduate School of Michigan State College in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

Another aspect of the nutrient question investigated involved the quantitative analysis of a group of aquatic plants for phosphorus and a comparison between the phosphorus content of the plant and that of the hydrosol upon which the plant was growing. Phosphorus in the plant material was determined by the standard Pemberton method (1), while all soil determinations were made by the Simplex method designed by Spurway (4) of the Michigan State College Soils Department. The object of this phase of the work was to learn something of the physiology of the aquatic vegetation and to determine the relationships between the content of a nutrient element in the plants and that of the soil. Phosphorus was selected because deficiencies of this element probably occur more generally in agricultural soils than do those of other elements. In relation to hydrosols, Pond (2) states that "the primary cause of retarded growth of anchored plants is their inability to secure enough phosphorus and potassium, and possibly other elements".

The results of these two phases of the work (the nutrient content of a variety of hydrosols and the phosphorus content of aquatic plants

Table 1. Available nutrients in sand.

Sample No.	Modifications or Inclusions	Water Hard	Soil (Air-dry)						Rooted Plants*
			pH	P ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	
2	much dark organic matter	14	7.5	..	..	100	...	tr	6-b
7	abundance of shells	13	9.0	tr	2	200	7	tr.	5-a
15	none	13	7.5	tr.	...	100	6	...	1-a
27	none	12	7.8	...	...	200	6	10	2-b
44	none	11	7.5	...	tr.	200	8	..	2-b
45	none	11	6.3	0.75	...	...	5	...	3-b
60	much organic matter		8.0	...	..	150	24	...	1-a
61	varying from dark gray to black, organic matter		7.0	tr.	...	125	8	...	1-a
63	considerable organic matter		8.0	...	..	175	16	...	3-a
64	dark color	12	7.5	0.5	..	175	8	...	5-b
65	brown color	12	7.2	0.5	...	...	4	...	10-b
67	marl mixed in	12	7.0	0.5	...	...	1	...	2-b
68	black, compact	8	5.5	tr.	20	...	6	...	6-a
70	none	8	5.5	...	...	...	4	...	...
71	none	13	7.5	...	...	...	1	...	4-b
72	none	11	5.0	tr.	...	100	7	...	3-a
Range:		8-14	5.0-9.0	0-0.75	0-20	0-200	0-24	0-10	

*The number indicates the number of plant species growing on the corresponding soil while the letters indicate the luxuriance of growth: a, very luxuriant growth, b, intermediate, and c, poorly developed. This has reference to thriftiness or luxuriance of growth—not density of stand.

In the data, blanks indicate that no test was made, while the symbol (...) means lack of response to test.

The foregoing procedures are carried out in tables 1 to 5, inclusive.

Table 2. Available nutrients in clay.

Sample No.	Modifications or Inclusions	Water Hard	Soil (Air-dry)						Rooted Plants
			pH	P ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	
5	none	14	8.0	tr.	tr.	200	7	tr.	2 - b
9	none	13	8.2	..	...	200	35	...	1 - b
10	none	13	9.0	tr.	...	200	40	..	...
13	none	13	7.5	tr.	...	200	24	tr.	1 - a
16	none	13	7.5	...	.	200	10	...	...
Range:		13-14	7.5-9.0	0-tr.	0-tr	0-200	7-40	0-tr.	

and associated hydrosols) are reported here, while those phases requiring further and more intensive investigation will be reported later. Detailed field methods will be omitted. Soil samples were collected from various lake bottoms and brought into the laboratory to be tested. Data taken at each collecting station included the depth, pH, temperature, and turbidity of the water, a list of the vegetation, and evidences of the degree of wave action. Chemical tests were not made on the lake water.

The lake soils have been divided into five broad types for the purpose of grouping the laboratory data. A brief description of the types used follows:

1. **Sand.** Soils included under this type are those whose outstanding characteristics are due to the sand content. Unless otherwise in-

Table 3. Available nutrients in slime.

Sample No	Modifications or Inclusions	Water Hard	Soil (Air-dry)						Rooted Plants
			pH	P ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	
1	none	14	8.0	tr	...	130	..	..	5 - b
6	none	14	7.5	tr.	2.0	175	6	tr.	5 - b
11	clay admixed	13	8.5	tr.	...	200	40	tr.	3 - a
12	marl and shells	13	8.5	tr.	..	200	24	.	1 - a
14	none	13	7.0	tr.	...	125	10	tr	1 - a
17	marl at depth of 2 ft.	13	7.5	..	...	200	15	...	4 - b
25	marl at depth of 4 ft		7.8	tr.	5.0	200	10	tr.	6 - a
48	Green color, shells included	11	7.8	...	..	150	8	.	3 - b
54	green color, very fluid	5	5.5	..	..		8	...	2 - c
102	marl and shells	14	8.0	1.5	...	200	7	..	9 - a
Range.		5-14	5.5-8.5	0-1.5	0-5	0-200	0-40	0-tr.	

licated, a clean, compact, light-colored sand will be implied when the term is used. Sand may be found in conjunction with marl, peat, shells, or very finely divided particles of organic matter. It should be realized that innumerable combinations of the various components may and do occur in nature. As previously mentioned, however, as long as the characteristics due to the sand are dominant, the soil will be included under this heading—the modifications when present will be given in a column provided for that purpose.

2. **Clay.** This term is used to designate those soils which are composed of extremely finely divided particles of inorganic material. As such, clay is generally found as a bluish-gray, sticky, and rather homogeneous deposit.

3. **Slime.** Water soils included under this heading are characterized by brown to black color, a semi-suspended condition of the components, and offering only a limited resistance to passage of heavier objects such as sounding leads. Here again, there are many possible intergrades between slime and the firmer deposits included under peat. Inclusions of all sorts may occur in slime. Some of the more common ones are marl, shells, sand, and clay. All degrees of decomposition of the plant fragments found in the slime also occur, giving a very variable texture.

4. **Peat.** Included under this type are those soils which, like slime, are composed of plant remains. Unlike slime, however, peat deposits

Table 4. Available nutrients in peat.

Sample No.	Modifications or Inclusions	Water Hard	Soil (Air-dry)						Rooted Plants
			pH	P ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	
11 5	gelatinous, green	13	7 0	tr.	...	125	3	...	3 - a
20	fibrous, prolific Chara growth, pH of water-8.5	13	5.5	0.5	...	125	14	...	5 - b
23	gelatinous, containing many small shells		8 0	1.5	...	200 +	8	...	3 - a
41	fibrous, containing many small shells	18	7.6	...	...	200 +	24	tr.	7 - a
47	gelatinous	11	7.0	0.5	...	125	16	...	4 - a
50	gelatinous	11	6 0	0.5	...	125	8	...	3 - b
52	gelatinous	5	5 0	...	...	...	8	...	3 - c
53	fibrous	5	5.0	...	...	...	8	...	2 - b
66	fibrous	12	6.5	tr.	...	150	20	...	2 - b
69	fibrous	8	6.5	0.75	...	150	10	...	5 - a
100	fibrous, marl under shore but not under bottom	16	8.0	...	...	200	24	...	5 - b
101	gelatinous	16	7.7	...	...	125	7	...	5 - b
107	fibrous	8	5.5	...	2.5	125	14	...	7 - a
130	fibrous, containing marl	8	8.5	...	...	200 +	7	...	...
Range:		5-18	5.0-8.5	0-1.5	0-2.5	0-200	3-24	0-tr.	

are more firm and when obtained with sampling devices, relatively firm material is obtained. This soil varies with the nature of the parent plant material, environmental conditions under which decomposition has occurred, and the degree of decomposition. Three distinct divisions are recognized: (a) fibrous—including all those deposits whose composition is largely fragmented remains of the rooted aquatic, marsh plants, and bog plants such as mosses, cattails, and leather leaf, (b) woody—composed chiefly of woody material, and (c) gelatinous or pulpy—originating from semi-microscopic forms and from easily disintegrated rooted aquatics and characterized by a uniform fine composition and a rather firm but gelatinous consistency. Again, inclusions may involve marl, shells, clay.

5. Marl. This type includes those water soils whose dominating characteristics are due to the marl content. Inclusions or modifications are listed in a column describing the particular deposit under consideration.

The series of tables (1 to 5, inclusive) gives the results of the rapid chemical tests made by the Simplex method which was designed to give a rapid test for available plant nutrients in soils. Tests for the following nutrients are possible with this test: nitrates, nitrites, ammonia, aluminum, magnesium, manganese, phosphorus, potassium, calcium, iron, sulphates, and chlorides. The tables presented give the amounts of

Table 5. Available nutrients in marl.

Sample No	Modifications or Inclusions	Water Hard	Soil (Air-dry)						Rooted Plants
			pH	P ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	
3	impure	14	9.0	tr		160	.	...	2-b
4	composed chiefly of very small shells	14	8.0		.	200+		..	2-b
8	none	13	8.5		.	200+	7	..	1-b
18	none	13	8.5	.	..	200+	8	..	.
19	impure, much organic matter	13	8.0		..	200+	24		2-b
21	none		8.0	.	...	200+	16	..	4-b
22	considerable organic matter		7.8	.	.	200+	6	.	6-a
24	numerous plant fibers		8.0			200+	8	.	2-b
26	none		8.0		tr	200+	8	...	...
28	none	12	8.2		..	200+	4		3-c
40	impure	18	7.8		.	200+	24	..	4-a
43	gelatinous peat admixed	9	8.5	...	...	200+	8	...	5-a
46	impure	11	8.5	...	...	200+	8	...	4-a
49	none	11	8.2	...	...	200+	8	...	3-c
51	none	11	8.5	...	...	200+	8	...	..
Range:		9-18	7.8-9.0	0-tr.	0-tr.	160-200	0-24	0	

some of the more important nutrients in the five broad water soil types. The nitrogen tests are omitted because when the sample is removed from the lake and allowed to remain in the laboratory, the state in which the nitrogen is present is undoubtedly changed and does not simulate its condition in the lake bottom. Hardness of the water is approximate and is expressed as grains per gallon.

An analysis of the data presented in the foregoing tables shows that lake soils vary widely in plant nutrient supply.

It is significant that the extremely acid peat and the pure, highly alkaline marl bottoms are almost completely deficient in available plant nutrients, particularly phosphorus and potassium. Observations show that lakes having a proportionately large percentage of these types of bottoms are low in productivity, not only with respect to vegetation but also with respect to plankton and fish production. Similar observations are recorded by Raymond (3) and Welch (6). Among the other types of bottoms, there seems to be no correlation between nutrient supply and the type and luxuriance of the plant communities. Certain plants prefer given types of soils, but the preference seems to be based on physical characteristics, such as firmness, subjection to wave action, rather than on the chemical constituency of the bottom.

Table 6 presents the results of the analysis of several different species of aquatic plants—giving the phosphorus content as determined by the standard Pemberton method. The soils upon which the plants were found have been tested for phosphorus by the Simplex method and those data are also included in the table. The reason for selecting phosphorus has been previously mentioned.

An examination of Table 6 indicates that there is a wide variation in the phosphorus content of aquatic plants. The percentages of P_2O_5 range from 0.189 to 1.105.

Different species of plants growing on the same soil absorb different amounts of phosphorus. In one case *P. amplifolius*, *Elodea*, *Myriophyllum*, and *Najas* were found growing together and contained the following percentages of P_2O_5 respectively: 0.400, 0.479, 0.816, and 0.727.

A single species of plant does not show a uniform phosphorus content but varies widely when grown in different lake soils, although the phosphorus content of the plant shows no relation to that of the lake soil. *P. natans*, for instance, contained 0.281 per cent P_2O_5 when growing on a soil containing 3.0 p.p.m. while another sample from a different lake contained 0.904 per cent P_2O_5 when growing on a soil containing only a trace of phosphorus. If aquatic plants obtain nutrients from the soil, they must have greater extracting powers than is generally supposed since the Simplex method is able to detect available phosphorus in concentrations of less than 0.5 parts per million, and in many cases plants showed a relatively high percentage of phosphorus when the corresponding soil failed to show even a trace by this test. However, if the nutrients were absorbed directly from the lake water, then a very minute amount of phosphorus in the lake water might supply the amount required by the plant for its metabolism.

It is interesting, in this connection, to note that two floating plants, *Lemna* and *Spirodela*, contained a higher percentage of phosphorus than all of the rooted plants, except for a sample of *Sagittaria* from Buttonbush Pond in St. Joseph County.

Table 6. Comparison of phosphorus content of aquatic plants and that of associated soils.

Lake	Soil	Phosphorus in soil (ppm.)	P ₂ O ₅ in plants (per cent)	Plant (s)	Sample No.
Pine L. Barry Co.	fibrous peat	0.0	.508	Brasenia	P-1
Pine L. Barry Co.	fibrous peat	0.0	.351	Najas	P-2
Craig L. Branch Co.	firm fibrous peat	0.5	.256	P. pectinatus	P-3
Craig L. Branch Co.	fibrous peat no sample taken		.227	Chara	P-4
Fish L. Oakland Co.	green gelatinous peat	0.0	.534	P. amplifolius	P-5
Fish L. Oakland Co.	slime too thin to get with sampler		.359	Brasenia	P-6
Square L. Oakland Co.	gray soft gelatinous peat and marl	0 0	.452	P. compressus, Chara, P. sp.	P-7
Pleasant L. Oakland Co.	green organic slime and shells	0.0	.441	Potamogeton sp.	P-8
Pleasant L. Oakland Co.	sand	0 75	.283	Potamogeton sp.	P-9
Pond on US-10, 3 mi. N.W. of Clarkston	sand and clay	0 0	.762	Myriophyllum, Chara and Green Algae	P-10
Mona L. Muskegon Co.	thin layer of fibrous peat over sand	tr.	1.098	Lemna, Spirodela	P-11
Pigeon L. Ottawa Co.	semi-fluid fibrous peat	0.75	.757	Chara	P-12
Cook L. Livingston Co.	brown fibrous peat	0.0	.833	Heteranthera	P-13
Bennett L. Livingston Co.	thin layer of black slime over coarse sand	1.5	.296	Chara	P-14
Kawbawgam L. Marquette Co.	brown gelatinous peat	0 0	.363	Pontederia	410- A
Kawbawgam L. Marquette Co.	brown gelatinous peat	0.0	.496	P. praelongus	410- P
Ross L. Marquette Co.	sand	0.0	.309	Isoetes	413- B
Ross L. Marquette Co.	sand	0.0	.663	Sparganium	413- A
Kawbawgam L. Marquette Co.	sand and fibrous peat	0.0	.254	Scirpus sp. Giant Bulrush	421- B
Little Bradford L. Otsego Co.	sand, gelatinous peat	0.5	.160	Chara	431- C
Little Bradford L. Otsego Co.	sand, gelatinous peat	0.5	.263	Potamogeton sp.	431- P
Little Bradford L. Otsego Co.	sand, gelatinous peat	0.5	.521	Nymphozanthus	431- W
Heart L. Otsego Co.	dark sand	3 0	.281	P. natans	432- N
Witch L. Marquette Co.	sand	0.0	.219	Scirpus sp. Giant Bulrush	433- S
Houghton L. Roscommon Co.	slime, gelatinous peat		.304	Vallisneria	439- C

Table 6. Continued.

Lake	Soil	Phos- phorus in soil (ppm.)	P ₂ O ₅ in plants (per cent)	Plant (s)	Sample No.
Houghton L. Roscommon Co.	slime, gelatinous peat		.534	Zizania	430- R
Big Perch L. Marquette Co.	dark sand	0.0	.262	Nymphozanthus	445- L
Big Perch L. Marquette Co.	dark sand	0 0	.360	P. Richardsonii	445- P
Little Perch L. Marquette Co.	sand	0.0	.491	P. gramineus	446- P
Little Perch L. Marquette Co.	sand	0 0	.791	Polygonum	446- S
Otsego L. Otsego Co.	sand, marl, sawdust	5.0	.400	P. amplifolius	468- A
Otsego L. Otsego Co.	sand, marl, sawdust	5.0	.479	Elodea	468- E
Otsego L. Otsego Co.	sand, marl, sawdust	5 0	.816	Myriophyllum	468- M
Otsego L. Otsego Co.	sand, marl, sawdust	5.0	.727	Najas	468- N
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	.526	Polygonum	504- A
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	.760	Utricularia	504- B
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	.788	Tolypella	504- F
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	.904	P. natans	504- N
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	.730	P. obtusifolius	504- P
Buttonbush Pond St. Joseph Co.	clay, organic matter	tr.	1.105	Sagittaria	504- S
Prairie River L. St. Joseph Co.	gelatinous peat, marl	0 0	.656	Ceratophyllum	507- C
Prairie River L. St. Joseph Co.	gelatinous peat, marl	0 0	.639	Peltandra	507- P
Silver L. Washtenaw Co.	sand, marl, organic matter	tr.	.189	Chara	512- C

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THE WEED PROBLEM OF THE UPPER PENINSULA

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Scientific research has evolved methods of weed control which under a given set of conditions are efficient and very satisfactory. Further research will no doubt discover even more efficient ways of combating weeds. Two major problems of weed control, however, seem to lie outside the field of scientific research which, if solved, would make the application of effective control measures much easier. Until these two problems are solved, weed control on anything like a community scale will be impossible. These two problems are: First, our present attitude of indifference toward weeds and second, our persistence in planting weed seeds.

After careful consideration of the foregoing situation, preliminary studies were started at the Upper Peninsula Agricultural Experiment Sub-station at Chatham. A weed nursery of approximately 150 species was planted and is being enlarged. The nursery is to be used as a laboratory for giving instruction in identification of weeds and also to furnish information on habits and characteristics of noxious weeds which may be useful in developing control measures.

To determine approximately the number of viable weed seed in the soils of the Upper Peninsula, soil samples were collected from cultivated fields, grain fields and permanent pastures on presumably weedy and clean farms from 14 Upper Peninsula counties. These 84 samples

Table 1. Viable weed seed per square foot from representative farms in Upper Peninsula counties.

County	Clean Farms			Weedy Farms		
	Pastures	Grain	Cultivated	Pastures	Grain	Cultivated
Alger	124	45	45	105	45	91
Baraga	18	17	37	130	81	31
Chippewa	31	58	5	169	877	—
Delta	27	53	65	45	59	89
Dickinson	164	0	63	95	59	61
Gogebic	206	27	23	78	165	155
Houghton	327	28	36	336	21	65
Iron	209	216	65	187	526	59
Luce	106	64	109	92	59	794
Mackinac	45	26	16	295	80	270
Marquette	138	520	31	16	110	59
Menominee	106	397	12	405	125	294
Ontonagon	223	77	20	240	325	36
Schoolcraft	43	94	18	1,957	28	161
AVERAGE	126	116	39	296	183	155

were planted in duplicate in the greenhouse and counts made of the weed seeds which produced plants. Results of these experiments are given in Table 1.

The number of samples is too limited to make definite conclusions regarding the distribution of weeds in the various counties or even over the entire farm from which the samples were taken. The data show, however, the number of viable weed seeds for the immediate area sampled and give some indication of what one might expect on surrounding parts of the field. The counts include only those weed seeds in the surface inch of soil. In fields that had been plowed a number of times many more weed seeds would be found in the next 5 or 6 inches of soil.

The data show a material difference in the number of weeds on the clean and on the weedy farms. The number of viable weed seeds was highest in pastures and lowest in cultivated fields. This may be explained at least in part by the fact that the viable weed seeds in pastures are the accumulation of several years with unfavorable conditions for germination. In cultivated fields the weed seeds are given an opportunity to germinate after which many of them are killed. With two possible exceptions, there were enough seeds present to give a perfect stand of weeds which leaves no room for crop production. Several of the fields, even on the presumably clean farms, were very heavily infested with weeds. When one considers that five to ten plants per square foot of such crops as alfalfa or clover constitute a very good stand he can appreciate the size of the weed problem that section is facing—particularly in view of the fact that seeds of many of those weeds retain their viability for many years.

With so many weed seeds in the soil the problem of weed eradication becomes much more serious. Many of the weeds were undoubtedly seeded with plantings of crop seed such as oats, barley, alfalfa and timothy. To determine the possibilities of such a method of introduction, weed seed counts were made at Chatham of 147 samples of grass seed offered for sale and 57 samples of grain (oats and barley) being seeded in the Upper Peninsula in 1939. The grass seed samples were collected from nine counties and the grain from eight counties of the Upper Peninsula. Weed seed, by species, per pound of crop seed were determined for each sample. The approximate total weed seed content

Table 2. The approximate total weed seed content of 147 samples of grass seed offered for sale in the Upper Peninsula in 1939.

Weed seeds per pound of grass	Per cent of samples
none	21.8
1—500	42.2
501—1,000	14.3
1,001—1,500	8.8
1,501—2,000	2.7
2,001—2,500	2.7
2,501—3,000	0
3,001—3,500	7
3,501—4,000	0
4,001—4,500	3.4
4,501—5,000	.7
exceeding 5,000	2.7

Table 3. Number and species of weed seeds found in 147 grass seed samples offered for sale in the Upper Peninsula in 1939.

Weed species	Per cent of samples containing	Weed seed per pound
Lambsquarter.....	32.7	822
Green foxtail.....	22.4	552
Field sorrel.....	19.0	641
Lady's thumb.....	9.5	272
Catchfly.....	8.8	460
Old witch grass.....	8.2	189
Curled dock.....	8.2	529
Pigweed.....	6.8	299
Buckhorn.....	6.1	1,542
Wild buckwheat.....	4.8	194
Quack grass.....	4.1	363
Cinquefoil.....	2.7	436
Canada thistle.....	2.0	242
Barnyard grass.....	2.0	151
Other species.....	15.6	1,455
Samples free of weeds.....	21.8	0

of the grass samples is given in Table 2. Slightly more than one-fifth of the samples were free of weed seeds, while nearly two-thirds of the total had fewer than 500 per pound. The other one-third might well be considered too weedy to plant. Table 3 gives the weed seed content by species of the grass samples. Lambsquarter was the most common weed mixture and was found in about one-third of the samples. Green foxtail and field sorrel were each found in approximately one-fifth of the samples. Buckhorn while in only 6 per cent of the samples was present in larger quantities than any other species except oxeye daisy. The latter, placed in the "other species class" was found in one sample of timothy at the rate of 20,000 seeds per pound.

Table 4 gives the approximate total weed seed content of the 57 grain samples analyzed. Only 3.5 per cent of the samples was free from weeds. Another 38.6 per cent contained fewer than 25 weed seeds per pound while more than one-fifth of the samples contained more than 200 per pound. Approximately 12 per cent of the samples met the requirements of certified seed insofar as weed seed content is concerned. Most of the remainder were too weedy to plant, yet the samples were presumably representative of what was actually planted.

Table 4. Weed seed content of 57 grain samples (oats and barley) just previous to seeding in the Upper Peninsula in 1939.

Weed seeds per pound of grain	Per cent of samples
none.....	3.5
1—25.....	38.6
26—50.....	15.8
51—75.....	8.8
76—100.....	1.7
101—125.....	1.7
126—150.....	1.7
151—175.....	1.7
176—200.....	5.3
exceeding 200.....	21.2

Table 5. Species and number per pound of weed seeds found in 57 samples of oats and barley seeded in the Upper Peninsula in 1939.

Weed species	Per cent of samples containing	Weed seed per pound
Wild buckwheat	78.9	37
Wild mustard	49.1	100
Quack grass	43.9	82
Canada thistle	29.8	17
Curled dock	21.1	24
Catchfly	19.3	32
Lambsquarter	12.3	25
Green foxtail	12.3	19
Yellow foxtail	7.0	14
Barnyard grass	5.3	1,130
Wild oats	5.3	40
Other species	38.6	17
Samples free of weeds	3.5	0

The weed species found in the samples, the percentage of samples in which they were found and the number per pound are given in Table 5.

Wild buckwheat was the most common, being found in approximately 80 per cent of the samples. Three of Michigan's seven noxious weeds were found in a high percentage of the samples. Grains are apparently a much more common source of those noxious weeds than grass seeds in the Upper Peninsula. The presence of so many weed seeds, especially of such species as wild mustard, catchfly and lambsquarter, in either oats or barley is evidence that fanning mills are not in use. Practically all of the weed seeds found in the grain samples could have been removed to a very high degree by running the seed over a good fanning mill.

Summary and Recommendations

The data given indicate the presence of a very serious weed problem in the Upper Peninsula and also that it is being perpetuated by the seeding of weedy grain and hay crop seeds. Other control or eradication methods will be of little avail until the practice of actually planting the weed seeds has been stopped. The first prerequisite, then, to a good weed eradication program is to plant clean seed. The grower should insist on clean seed; it is worth a premium. Any home-grown seed should be cleaned before seeding. If a fanning mill is not privately owned, have the seed cleaned at an elevator. Where there are no elevators or equipment available, a centralized cleaning plant could perhaps be set up which could, under proper management, do an immeasurable amount of good in making clean seed available.

Crop rotation, good seedbed preparation, summer fallow, clipping, and other recommended practices will go a long way toward eradication of weeds on most farms of the Upper Peninsula—only when and if growers stop planting weed seeds.

THE PROPER COLLECTION OF MILK SAMPLES FOR STREPTOCOCCIC MASTITIS TEST

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SECTIONS OF BACTERIOLOGY AND ANIMAL PATHOLOGY

Approximately 98 to 99 per cent of all infectious mastitis of dairy cows is caused by the streptococcus group of bacteria. Streptococcic mastitis is a major herd problem, since (1) it reduces milk and butter-fat production approximately 25 per cent, (2) the bacteriological quality of the milk secreted by infected cows is reduced approximately 50 per cent, (3) the rapid spread of the infection through the herd increases herd wastage, (4) the streptococci in the infected milk may be capable of producing human distress if such milk is consumed in the raw state.

Streptococci of either animal or human origin can cause streptococcic mastitis in the cow. The necessity for employing sanitary procedures in handling the dairy herd is obvious.

The microscopic test for streptococcic mastitis consists in the microscopic examination of a properly collected and incubated (at 37° C. for at least 12 hours) milk sample from each lactating cow. The streptococci of human and other sources, that may contaminate the samples as a result of faulty technic during collection of the milk sample, will reproduce and, morphologically cannot be differentiated from those actually causing udder infection. All bacteria, other than streptococci, that may contaminate a milk sample owing to faulty technic of collection will reduce the accuracy of the test results. It is therefore essential to employ a technic that will exclude all contamination from the outside, thus yielding a sample which bacteriologically will indicate the presence or absence of infection of the udder, the bacteria present in the sample being only from within the cow's udder.

The following data indicate faulty technic in collecting milk samples for test, as sources of error in the results of the microscopic test for streptococcic mastitis:

1. **Milk samples for test must not be collected within a period of two hours following the regular milking.** The data of Table 1, representative of those obtained in many herds, demonstrate this requirement. Approximately 50 per cent of the infected cows yielded a negative test result when samples were collected too soon after milking the animals. Apparently the streptococci in the milk cistern and ducts of the udder were completely flushed out with the milk and were not replaced by bacteria from the deeper regions of the udder within the approximate two-hour period.

2. **A chlorine solution (approximately 200 p.p.m.) must be used to wash the udders and teats prior to collecting the milk sample for test.** Washing the udders and teats with water is not sufficient to insure accurate test results, as indicated by the data of Table 2. The chlorine

Table 1. The influence of collecting milk samples for test within two hours after milking upon the results of microscopic tests* for streptococcic mastitis.

Cow No.	Properly collected (any time except within two hours after milking) milk sample	Samples collected within two hours after milking
1.....	—	—
2.....	—	—
3.....	—	—
4.....	—	—
5.....	—	—
6.....	—	—
7.....	—	—
8.....	—	—
9.....	—	—
10.....	+	—
11.....	+	+
12.....	+	+
13.....	+	+
14.....	+	+
15.....	+	—

* + = streptococcic mastitis infection; — = no infection.

killed all streptococci as they were introduced into the solution while the water alone did not kill them. Actually the water served as a reservoir of streptococci with a possibility of transfer of the infective bacteria upon washing additional cows. Furthermore, the number of streptococci in the water increased following the washing of two posi-

Table 2. The influence of solution used to wash udders on the results of microscopic test for streptococcic mastitis and the presence of living streptococci in the solution. In each case the fore milk was discarded into a strip cup prior to collecting the milk samples.

Cow No.	Udders washed with chlorine solution (200 p.p.m.)		Udders washed with clear water	
	Microscopic test result of milk*	Streptococci** in wash solution	Microscopic test result of milk*	Streptococci** in wash solution
1.....	—	—	—	—
2.....	—	—	—	—
3.....	—	—	—	—
4.....	—	—	—	—
5.....	—	—	—	—
6.....	—	—	—	—
7.....	+	—	+	+
8.....	—	—	—	+
9.....	—	—	—	+
10.....	+	—	+	+
11.....	+	—	+	+
12.....	—	—	+	+
13.....	—	—	+	+
14.....	+	—	+	+
15.....	+	—	+	+
16.....	+	—	+	+
17.....	+	—	+	+
18.....	—	—	+	+

* + = streptococcic mastitis infection; — = no infection.
** + = living streptococci present; — = none present.

tive cows to the extent that the udders of subsequent negative cows were sufficiently contaminated by the streptococci to yield a positive result on microscopic test of milk samples from these cows. A clean cloth must be used to wash the udder and teats with chlorine solution.

3. **The first two streams of milk from each quarter must be discarded into a strip cup prior to collecting the milk sample in the mastitis sample vial.** This must follow careful washing of the udders and teats with chlorine solution as indicated in 2. Failure to follow the foregoing procedure may introduce contaminating bacteria that will interfere with the accuracy of the microscopic test results (Table 3). Discarding the fore milk but failing to wash the udders and teats resulted in the contamination of one sample with a streptococcus that was not present in the cow's udder. Similar contamination resulted in four instances where neither the udders were washed nor the fore milk discarded prior to collection of the sample. In each case the streptococcus contamination was responsible for a positive test result when actually the cows were negative (not infected). These results demonstrate the need for washing the udders and teats with chlorine solution and discarding the fore milk prior to collecting a milk sample for testing.

Table 3. The influence of system of sampling on the microscopic test results.

Cow No.	System of sampling and microscopic test results		
	Udders not washed. Fore milk not discarded	Udders not washed. Fore milk discarded	Udders washed*. Fore milk discarded. (Samples properly collected)
1	—	—	—
2	+	—	—
3	—	—	—
4	—	—	—
5	+	—	—
6	+	+	—
7	+	+	+
8	—	—	—
9	+	+	+
10	—	—	—
11	—	—	—
12	+	—	—
13	+	+	+
14	+	+	+

*Chlorine solution. 200 p.p.m. chlorine used for washing udder and teats.

4. **Only milk samples from lactating cows can be tested with any degree of accuracy.** Do not submit samples from dry cows or cows that have recently freshened. The colostrum does not permit making a suitable preparation for microscopic examination.

5. **A composite milk sample must include a small amount of milk from each of the four quarters if the results of the microscopic test are to indicate accurately the status of the cow.** If milk is submitted from only three-quarters and a negative test result is obtained the infection in the fourth quarter is missed. This infection causes the

fourth quarter to produce less milk, abnormal milk, or even has caused that quarter to go "blind". A small amount of milk or secretion from each quarter of each lactating cow must be submitted to insure accurate test results.

6. **The sample must be collected by milking directly from each quarter into a mastitis vial.** Funnels, buckets, and strainers should not be used to collect milk samples for test. The milk of a positive cow will contaminate such utensils with streptococci and thereby contaminate subsequent milk samples from negative cows with the streptococcus causing the negative cows to be called positive on test. In one instance a funnel was used to collect milk samples from a herd of nine cows. All were positive on microscopic test. Investigation revealed that the first cow sampled was a positive cow. The streptococci contaminated the funnel, which in turn contaminated each of the eight other milk samples. These eight cows were proved to be negative on subsequent repeated tests.

7. **The cork of sample vial must be held in such a manner that the part which goes into the vial, and comes in contact with the milk, is not contaminated in any way.** The following data clearly demonstrate this point. The person collecting samples from a herd of 50 cows was holding the cork in his mouth while collecting the milk samples. Twenty-five or 50 per cent of the cows gave a positive result upon test whereas on previous tests only five or 10 per cent had streptococcic mastitis. Investigation revealed that the person had a mild streptococcus sore throat at this time; consequently some of the corks became contaminated with streptococci from the mouth. This contamination was responsible for the positive results of the milk samples collected from non-infected cows. It is advisable to have a second person hold the cork in his hand while the first person collects the milk sample. The cork may be held between the fingers of the hand holding the vial.

8. **The person collecting milk samples for test must wash his hands in chlorine solution (200 p.p.m.) prior to sampling each cow, and dry them on a clean towel.** This procedure is essential to prevent the contamination of milk samples, and is even more important from the standpoint of preventing the spread of the streptococcus through the herd.

9. **Do not send milk samples to reach the laboratory over a weekend.** Storing milk samples in the warm post office for several days hastens deterioration of the samples. Samples that have undergone such deterioration are not suitable for accurate test.

10. **Do not send in milk samples for test if they are not in mastitis vials containing the preservative.** The differential preservative is necessary to have the properly collected milk sample reach the laboratory in a suitable condition for test.

Summary

Milk samples for microscopic test for streptococcic mastitis should only be submitted from lactating cows, excluding those near the beginning or end of lactation. They should be collected by milking directly into the mastitis vial.

The milk sample must include a small quantity of milk from each quarter of the cow if the test result is to indicate the status of the cow. The samples must not be collected within a period of two hours following the regular milking.

The technic for proper collection of milk samples for microscopic test is as follows:

1. Wash udder and teats with chlorine solution (200 p.p.m.).
2. Discard two streams from each quarter into a strip cup.
3. Collect a 5 cubic centimeter composite sample by milking directly into the sterile mastitis vial containing the preservative, being careful not to touch the part of the cork that goes into the vial.
4. Wash hands in chlorine solution (200 p.p.m.) between cows.
5. Identify each sample.

The samples should not be mailed to reach the laboratory over a week-end since storage at warm temperatures hastens deterioration of the sample.

SPRAYING FOR GRAPEBERRY MOTH CONTROL, 1939

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During the season of 1939 a spraying program for control of grapeberry moth was undertaken in the grape belt of Van Buren County where varied success in control of that pest has been reported for the past few years.

The spraying was conducted in a cultivated vineyard with an average infestation. Six-row plots comprising between one and two acres were used. The spraying equipment consisted of a tractor-drawn sprayer equipped with a 300-gallon tank, power take-off and covered spraying booms. The only equipment items requiring explanation are the covered booms, which consisted merely of inverted U-shaped sheet iron hoods fixed to a frame on the sprayer and spaced to cover the vines. Four nozzles are used on each side of the vine. Covered booms permit an arrangement of nozzles, assuring penetration of spray materials into the bunches without exposing the driver to a bath of spray. In other words, covered booms give better control with the same amount of spray material by insuring coverage of fruit as well as foliage.

The number of sprays, the materials used and the results attained with the applications are set forth in the following tabulation.

Timing of Sprays

Applications were made as follows except when otherwise indicated in the tabulation: 1. When shoots 4-6 inches long; 2. Just before bloom; 3. Just after bloom; 4. 7 days after 3; 5. 7 days after 4.

*In cooperation with John Woodman, County Agricultural Agent, Van Buren County, the Welch Company, and various growers. Without their assistance the work could not have been accomplished.

Tabular presentation of experimental spraying Paw Paw, 1939.

Schedule	Application	Fungicide	Insecticide	Sticker-Spreader	Clean Grapes Per cent
1	1	B 8-8-100	L.A. 3 lb	3 qt. oil	95.1
	2	B 8-8-100	L.A. 3 lb	3 qt. oil	
	3	B 8-8-100	L.A. 2 lb	1 lb. casein-lime	
	4	B 8-8-100	L.A. 2 lb	1 lb. casein-lime	
	5	B 4-6-100	Nicotine sulphate 1 pt.	1 lb. casein-lime	
2	1	B 8-8-100	C.A. 3 lb	3 qt. oil	98.7
	2	B 8-8-100	C.A. 3 lb	3 qt. oil	
	3	B 8-8-100	C.A. 2 lb	1 lb. casein-lime	
	4	B 8-8-100	C.A. 2 lb	1 lb. casein-lime	
	5	B 4-6-100	Nicotine sulphate 1 pt.	1 lb. casein-lime	
3	1	B 8-8-100	L.A. 3 lb	3 qt. oil	98.8
	Extra*	B 8-8-100	L.A. 3 lb	3 qt. oil	
	2	B 8-8-100	L.A. 2 lb	3 qt. oil	
	3	B 8-8-100	Nicotine sulphate 1 pt.	3 qt. oil	
	4	B 4-6-100	Nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
4	1	B 8-8-100	L.A. 3 lb	3 qt. oil	97.9
	Extra*	B 8-8-100	C.A. 3 lb	3 qt. oil	
	2	B 8-8-100	C.A. 2 lb	3 qt. oil	
	3	B 8-8-100	Nicotine sulphate 1 pt.	3 qt. oil	
	4	B 4-6-100	Nicotine sulphate 1 pt.	3 qt. oil	
5	1	B 8-8-100	L.A. 3 lb. plus nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	99.1
	2	B 8-8-100	L.A. 3 lb. plus nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
	3	B 8-8-100	L.A. 2 lb. plus nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
	4	B 8-8-100	L.A. 2 lb. plus nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
	5	B 4-6-100	Nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
6	1	B 8-8-100	L.A. 3 lb	3 qt. oil	95.5
	2	B 8-8-100	L.A. 3 lb	3 qt. oil	
	3		Kutane		
	4		Kutane		
	5		Nicotine sulphate $\frac{3}{4}$ pt.	3 qt. oil	
7	1	B 8-8-100	L.A. 3 lb	3 qt. oil	98.9
	2	B 8-8-100	L.A. 3 lb	3 qt. oil	
	3	B 8-8-100	L.A. 2 lb	1 lb. Casein-lime	
	4	Cuprocide 54y 1 lb.	B.L. 155 Conc. 3 lb	3 qt. oil	
	5	Cuprocide 54y 1 lb.	B.L. 155 Conc. 3 lb	3 qt. oil	
8	1	B 8-8-100	L.A. 3 lb	3 qt. oil	98.7
	2	B 8-8-100	L.A. 3 lb	3 qt. oil	
	3	B 8-8-100	L.A. 2 lb	1 lb. Casein-lime	
	4	Cuprocide 54y 1 lb.	B.L. 155 Conc. 3 lb		
	5	Cuprocide 54y 1 lb.	B.L. 155 Conc. 3 lb		
	6†	Cuprocide 54y 1 lb.	B.L. 155 Conc. 3 lb		

*Note: Extra about 7 days after No. 1.

†Note: No. 6 applied 8 days after 5.

In the tabulation B = bordeaux; L.A. = lead arsenate; C.A. = Calcium arsenate; B.L.155 = Black Leaf 155; B.L. 155 Conc. = Black Leaf 155 Concentrate; and Kutane = Cuprous Cyanide.

Residue

At harvest, samples of grapes were collected and analyzed for residue. In no case did the residue approach the tolerance of 0.01 grain per pound of fruit. It is believed that bunching the sprays as indicated by the statement about timing was the important factor in keeping down residues. At least residues from grapes sprayed at later dates with lead arsenate in this and other years have shown residues beyond the tolerance limit.

Discussion

Nicotine sulphate was used in the last application of schedule for leafhoppers but is included in the tabulation because it undoubtedly kills some berry moth.

The most outstanding thing to be gained from inspection of the tabulation is that calcium arsenate is as effective against grapeberry moth as lead arsenate used in the same way. The two most important implications of this are that calcium arsenate offers a possibility of cost cutting and eliminates lead residue.

It is also apparent that the fixed nicotine and cuprous cyanide offer alternatives that will be studied further. The controls obtained with these materials, particularly the fixed nicotines, are satisfactory.

The intriguing thing about the fixed nicotines (B. L. 155 Concentrate) is that a program controlling both grapeberry moth and grape leafhopper may be possible with this one material and at a cost strictly comparable to the present practice of using arsenicals for grapeberry moth and nicotine sulphate for leafhopper. Protection against black rot with a schedule of fixed nicotine (incompatible with bordeaux) is apparently possible by attention to early bordeaux sprays and the use of low-soluble copper (Cuprocide 54y) in those sprays containing fixed nicotine.

The control of grapeberry moth obtained by sprays of fixed nicotine in this experimental spraying are strictly in accordance with growers' results on nearby farms.

Another fact apparent in the tabulation is that practically all materials gave excellent control. Growers' results vary. The only logical conclusion then is that the application differed from that by growers. The arrangement of nozzles beneath a hood was the only departure from conventional spraying methods and apparently the value of such a device is demonstrated by the results attained.

EXPERIMENTS ON THE PRODUCTION OF ALFALFA HAY

S. T. DEXTER
SECTION OF FARM CROPS

The state of Michigan might be divided into two regions from a forage standpoint. In one region, alfalfa and other legume or mixed hay is the rule, while in the other, grass hay is most widely grown and legume hay is the exception. In the grass hay region generally,

and in some parts of the region where alfalfa hay is common, the production of corn for silage is usually considered of doubtful practicability. A report of experiments on the production of high quality hays in the grass hay region has already been published in the *Quarterly Bulletin of the Station*.^{*} In general, early cutting of fertilized meadows gave improved yields of a superior forage which could be preserved as grass silage, or, weather permitting, cured as hay. The use of hay crops for silage has received and is receiving much of our attention experimentally.

In a large part of the Lower Peninsula of Michigan, alfalfa hay is grown with little difficulty. On many farms there is no problem of protein deficiency. Even in the ration of a dairy cow, a proper balance of nutrients can be obtained by the use of home-grown grains and alfalfa hay. Alfalfa hay, however, although high in digestible protein, is not particularly high in total digestible nutrients. Early cut grass hays readily may surpass it in total digestible nutrients and in net energy. To improve the quality of alfalfa hay and to increase its productive value in a ration, it has been suggested that the crop be harvested early, although with a sacrifice in yield. The advantage in digestibility of bud-stage alfalfa hay over that cut at full bloom is sometimes problematical. The late-cut hay may be cured, perhaps, under such desirable conditions that it is of exceptional quality, while much of the original quality of early-cut hay may be lost if rain and cool weather interfere with the curing process. Even so, on farms where home-grown grain is relatively scarce, the palatability and consumption of the hay may be as important as superior digestibility, and early-cut hay may be consumed in greater amounts than hay cut in full bloom. The emphasis on soil conservation and erosion control tends to increase the proportion of hays in the ration. In fact, in some regions it may be found advantageous if the production of grains is virtually eliminated, and the use of concentrates is limited to those purchased to supplement the home-grown forage. In a region where legume protein is abundant, and home-grown grains scarce, some sacrifice or waste of protein might be considered advisable if thereby increased digestibility or consumption, or both, could be obtained. In other regions, yield, ease of handling or maintenance of stand might be controlling considerations.

Reseeding to Thicken and Maintain Old Stands of Alfalfa

The stand in many alfalfa fields of Michigan becomes thin and patchy after a year or two, of cutting. Poor drainage, with resultant heaving or ice-sheets, has been a predominant cause. Bacterial wilt of alfalfa is becoming an important factor. Other fields are so located that frequent plowing is undesirable from the standpoint of erosion control. In 1935, an experiment was started to determine the possibility of thickening a patchy stand on a poorly drained field at East Lansing; 120 plots were laid out, 60 for seeding in the spring (April 25) and 60 for seeding in the fall (Aug. 21, 1935). In four replicate plats each, alfalfa (4 lb.), red clover (4 lb.), alsike clover (2 lb.), sweet clover (6 lb.), timothy (5 lb.), smooth brome grass (5 lb.), tall oat grass

^{*}Dexter, S. T. and Clanahan, D. L. Early cutting and fertilization of quack grass meadows. *Mich. Agr. Exp. Sta. Quart. Bul.* **21** (3): 176-179. 1939.

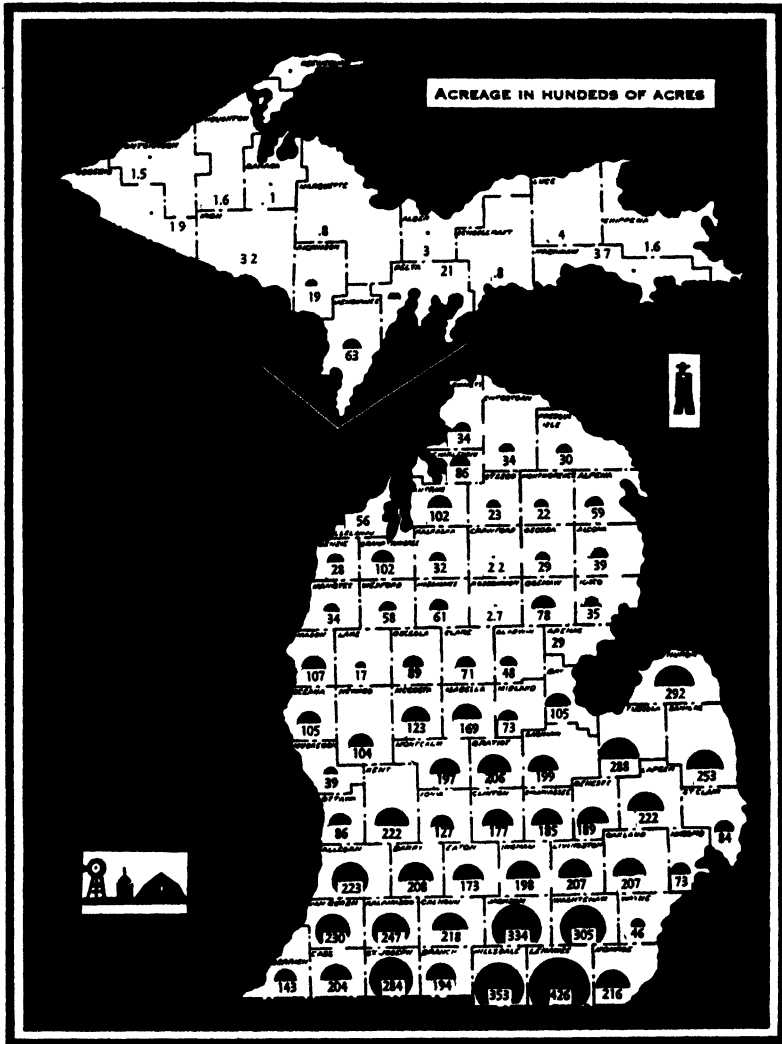


Fig. 1. Michigan alfalfa hay acreage, 1935.

(5 lb.), orchard grass (5 lb.), domestic ryegrass (5 lb.), meadow fescue (5 lb.) and reed canary grass (3 lb.) were seeded both spring and fall at the rates per acre shown. A mixture of timothy (1 lb.), orchard grass (1 lb.), red clover (1 lb.) and alsike clover (1 lb.), and a mixture of the other grasses, 1 pound each, was also sown. In both spring and fall, the ground was scratched up somewhat with a spring-tooth harrow, and the seed broadcast and covered with a spike-tooth harrow.

Legume seedlings were considered a **complete failure**, in either spring or fall seeding. No new seedling plants of alfalfa, alsike, or sweet clover could be found. Occasional red clover plants developed. All the

grasses made a fair "catch," although reed canary grass, smooth brome-grass, and meadow fescue were slow to make much growth.

The three most promising grasses, both in stand and in yield were timothy, tall oat grass, and orchard grass. In general, the stand of grass was good where the alfalfa was thin, and little grass became established where the stand of alfalfa was heavy. Since there appeared to be little difference between spring and fall seedings, the yields of the eight plats seeded to timothy, timothy and orchard, and to tall oat grass have been averaged, in each case, and are presented in Table 1.

Table 1. Yields of hay (oven dry basis) per acre from an old stand of alfalfa, with and without reseeding, in 1935.

Reseeded with	1936			1937			2-Year Total
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	
Timothy.....	3,629	936	4,565	4,386	1,298	5,683	10,248
Orchard grass....	3,575	868	4,443	3,903	880	4,783	9,226
Timothy and orchard grass.....	3,510	861	4,371	3,871	1,284	5,155	9,526
Tall oat grass.....	3,497	816	4,313	4,088	1,596	5,884	10,197
Average of grasses.....	3,553	870	4,423	4,062	1,265	5,327	9,750
No reseeding.....	3,149	853	4,002	2,797	472*	3,269	7,271

*Not worth cutting.

The data in Table 1 indicate the success of the grasses in thickening the stand. The yield was increased and weeds were kept out. During the second year of cutting, 1937, bacterial wilt spread rapidly through the field, leaving little but weeds for the second cutting on the unseeded plats. A fair crop of grass hay, mixed with alfalfa was obtained on the reseeded plats. Although tall oat grass was outstanding in the production of a second cutting, there seems no reason for using it generally in preference to timothy.

Since this experiment was performed, bacterial wilt has become relatively common in Michigan. In fields badly infested with wilt, re-seeding seems impracticable, since it will not save the alfalfa. Under conditions of poor drainage, the inclusion of a small amount (1 or 2 pounds per acre) of timothy seed in the original seeding probably would be more desirable than reseeding.

Cutting Management of Alfalfa

That the cutting management of alfalfa can affect materially the yield and quality of the hay and the longevity of the stand has been demonstrated repeatedly. Nevertheless, in the light of new developments and new emphasis in agriculture, it seemed desirable to lay out a series of plats to test the effects of numerous cutting practices. Many farmers no longer have trouble in getting good alfalfa stands. Some use the crop in short rotations. Local seed is often available and relatively inexpensive. Bacterial wilt is becoming so prevalent that management to insure longevity is ineffective.

In 1935, plats were laid out in a field seeded in 1932. It had been used for hay curing experiments in 1933 and 1934, but the stand was generally excellent. Four replicate plats were provided for each cut-

Table 2. Yields of alfalfa hay (oven-dry basis) per acre resulting from various systems of cutting management. Seeded 1932, cut uniformly 1933 and 1934.

Plat No.	Cutting system			Yearly yield 1935	Yearly yield 1936	1st cut yield 1937	Cuts	Total Yields	
	1st cut	2nd cut	3rd cut					Dry Mat.	Protein
1	pre-bud ...	pre-bud ...	Fall(10/15 to 11/1)	5,541	3,718	1,378	7	10,637	2,331
2	pre-bud ...	full bloom	Fall ..	6,182	4,526	1,282	7	11,990	2,525
3	bud	bud	none	5,731	4,141	3,805	5	13,677	2,681
4	1/10 bloom	1/10 bloom	none	6,376	4,782	3,672	5	14,830	2,668
5	full bloom	full bloom	none	6,669	4,270	4,220	5	15,159	2,477
6	1/10 bloom	full bloom	Fall	7,022	5,612	3,489	7	16,223	2,976
7	full bloom	full bloom	Fall	7,137	5,148	3,383	7	15,704	2,652
8	full bloom	1/10 bloom	none	6,943	4,598	4,078	5	15,618	2,573
9	1/10 bloom	full bloom	none	6,387	5,122	4,065	5	15,574	2,777
10	full bloom	pre-bud ..	Fall	6,692	5,534	3,554	7	15,780	2,702

ting treatment. These treatments were continued on the same plats for three seasons, 1935, 1936 and 1937. During 1936, a little bacterial wilt became noticeable in the plats. Although there was an excellent first cutting in 1937, by the middle of the summer the stand was almost completely destroyed.

Table 2 summarizes the data on yield of dry matter and protein on these plats for the three years. The terms used to indicate the stage of development are as follows: **Pre-bud**, which indicates that the floral parts were still small, the buds fuzzy and with no color showing; **bud**, full-bud stage, with a very few first blossoms showing in the field, but in general with no color in the buds; **1/10 bloom**, an indefinite stage, that might well be estimated at $\frac{1}{4}$ bloom by another observer; **full bloom**, also difficult to determine definitely, particularly in seasons when blooming is long prolonged. In one year, a period of more than three weeks was required to pass from the bud stage to the full bloom stage; in another year, less than two weeks. The plan of the experiment was to harvest the first cutting when maximum growth had been obtained. This would be normally when the alfalfa was in full bloom. In a few cases, however, dropping of leaves at this stage may have resulted in moderate yield losses.

Fall cutting at the time of the first heavy freeze appeared to be more injurious following cuttings taken in late August than on areas cut the second time about August 15. Plats cut twice only at the

Table 3. Yields in the first cutting from plats receiving two cuttings only at the bud stage or at greater maturity, and when cut additionally in the fall.

Column.....	1	2	3	4	5	6	7	8
Plat*	3	4	5	8	9	7	6	10
Cutting—1st ..	Bud	1/10 bl	Full bl.	Full bl	1/10 bl	Full bl.	1/10 bl.	Full bl
Cutting—2nd..	Bud	1/10 bl.	Full bl.	1/10 bl.	Full bl.	Full bl.	Full bl.	Pre-bud
Cutting—3rd..	—	—	—	—	—	Fall	Fall	Fall
1935.....	3,139	3,589	4,064	4,078	3,649	4,099	3,572	3,993
1936.....	3,154	3,887	3,738	3,975	3,964	3,524	3,451	3,773
1937.....	3,805	3,672	4,220	4,078	4,065	3,383	3,480	3,554

*See Table 2.

full-bud stage or later suffered little winter injury throughout this experiment. Table 3 presents these data.

The data in column 1, Table 3, reveal that two cuttings, each at the bud stage, in 1935 and 1936, left plat 3 in excellent condition in 1937. If the data in column 6 are compared with those in column 3, however, it appears that fall cutting following cutting late in August was definitely injurious. Other comparisons will show that all fall cuttings were injurious, but perhaps not to so great a degree. **The foliage of plants cut either in late July or in late August was more injured by fall frosts than was the foliage of plants cut about August 15.** On plats cut about August 15, the new fall growth remained green and active for photosynthesis until after the heavy freezes of late October. Fall cutting, in this experiment, was delayed until heavy freezes killed the tops, but not later than November 1.

In regions of Michigan where alfalfa is sold to driers for the production of alfalfa meal, the crop is generally harvested at rather immature stages of growth and preferably after having been cut in the fall (to avoid old stems in the spring growth). By this means, the number of days of operation of the drier is increased, and a product high in protein and low in fibre is produced. From the standpoint of the operator of the drier, these considerations are obviously very important. It may be of interest to examine a little more closely the effects on the yield and on the stand when such early cutting is practiced. Table 4 presents these data. Plat 1, cut twice in the pre-bud stage and once in the fall, was badly injured **before the fall of the first year.** Plat 2, pre-bud, full bloom, and fall cutting, showed little indication of injury the first year. In the second year, severe injury was evident after the first cutting. These pre-bud cuttings were taken on May 31. The yield when taken at the bud stage was about 50 per cent greater than when taken at pre-bud. When the first cutting was made at the ordinary time of cutting alfalfa, the yield was approxi-


























YIELDS OF HAY PER ACRE									TOTAL YIELD OF HAY	TOTAL YIELD OF PROTEIN
PLAT TREATMENT	1935 CUTTINGS			1936			1937			
	1st	2nd	3rd	1st	2nd	3rd				
PLAT 1	 PREBUD	 PREBUD	 OCT. 18	 PREBUD	 PREBUD	 OCT. 30	 PREBUD		10637	 2331
PLAT 9	 1/10 BLOOM	 AUG. 15		 1/10 BLOOM	 AUG. 13		 1/10 BLOOM		15574	 2777
PLAT 6	 1/10 BLOOM	 AUG. 15	 OCT. 15	 1/10 BLOOM	 AUG. 13	 OCT. 30	 1/10 BLOOM		16223	 2976

Fig. 2.

mately double that of the plats cut at the pre-bud stage. Yields for the year are given in Table 2. Table 4 and Fig. 2 give greater detail. These show clearly that frequent cutting at early stages gives low yields, and leads to injured stands. Cutting about June 1 is likely to be fatal to the stand even in the first year of such cutting, particularly when the second cutting is not delayed. Hay from these early cuttings, although very high in protein and low in fibre, is desirable in alfalfa meal, and may be necessary for the drier operator to fulfill a guaranteed analysis. A long season of operation of the drier is undoubtedly necessary. In any case, when such a product is sold to a drier, a large premium in price should be obtained, in view of the decreased yield per acre and the certain injury to the stand. Alfalfa should never be cut at immature stages when the duration of the stand is a major consideration. If a sufficient premium in price can be obtained to offset the decreased yield and the expense for reseeding, or if the field is to be plowed up in any case, cutting and sale of immature alfalfa may be justified.

Table 4. Yields in the first cutting over a period of three years, as indicating the condition of the stand, and the profit in early cutting for driers.

Plat	Cutting system (as in Table 2)	Average date cut	Yield of dry matter in first cutting			Average Per cent Protein
			1935	1936	1937	
1	Pre-bud	May 31	2,321	1,874	1,378	23 28
2	Pre-bud	May 31	2,219	2,335	1,282	23 28
3	Bud	June 11	3,139	3,154	3,805	19 31
4	1/10 bloom	June 19	3,615	3,925	3,869	17 69
5	Full bloom	June 30	4,071	3,857	4,149	16 14

Conclusions

From the results of this experiment, it can be seen that the general practice in Michigan, based on experience and previous experiments, is still desirable. To get the greatest yield in two cuttings, the first cutting should be taken when the plants are blooming. There is no advantage in delaying cutting until full bloom. The second cutting should be taken about the middle of August in most of Michigan. Cuttings made after the first killing frost may increase the yield per acre somewhat, but good management is necessary when three cuttings are taken. Poor management or cutting at improper stages is likely to result in lower total yields from three cuttings than from two cuttings properly taken. The extra labor involved in an additional cutting may be justified only when feed is scarce, although local conditions or unusual weather conditions may cause exceptions. For the most economical production of high yields of alfalfa hay, two cuttings in the bloom stage remains the rule for most of Michigan.

CANNING BEETS NEED BORON

R. L. COOK AND C. E. MILLAR*
SECTION OF SOILS

For several years Michigan growers and canners of garden beets have experienced difficulty with internal break-down or black-spot in the beets. It has been shown that this abnormality is caused by a deficiency of available boron in the soil and it appears in the root in the form of black areas of corky tissue, located more often near the surface but sometimes in the central portions of the root. The spots are usually found closer to the lower tips than to the crown, but in extreme cases may be scattered throughout the beet.

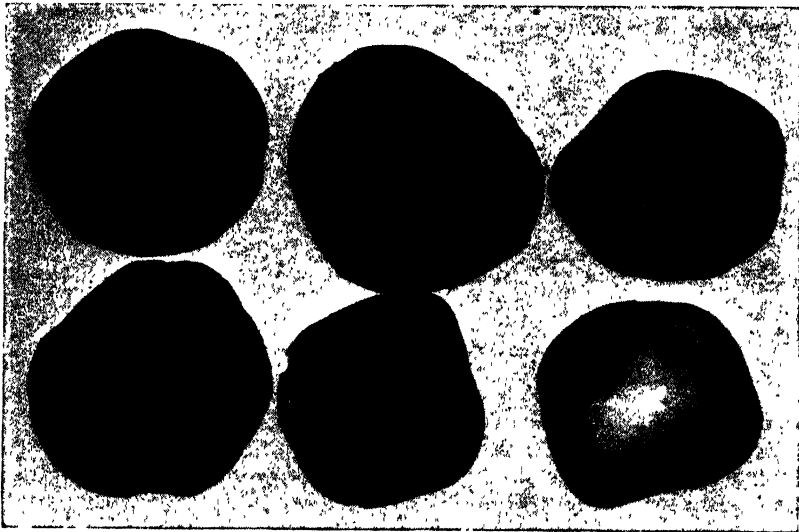


Fig. 1. Cooked slices from garden beets containing black corky tissue as a result of boron starvation.

As shown by the beet slices in Fig. 1 the corky areas are very evident in the cooked beets. At times they seem even more pronounced in the cooked than in the raw slices, probably because the corky tissue is affected to a lesser extent by cooking than is the normal tissue which is somewhat bleached. The result is a greater contrast of colors. The corky tissue, although tasteless, is unsightly and tough and for those reasons must be excluded from the packed product.

*Acknowledgment is made to G. R. Muhr for assistance in the experimental work reported in this paper.

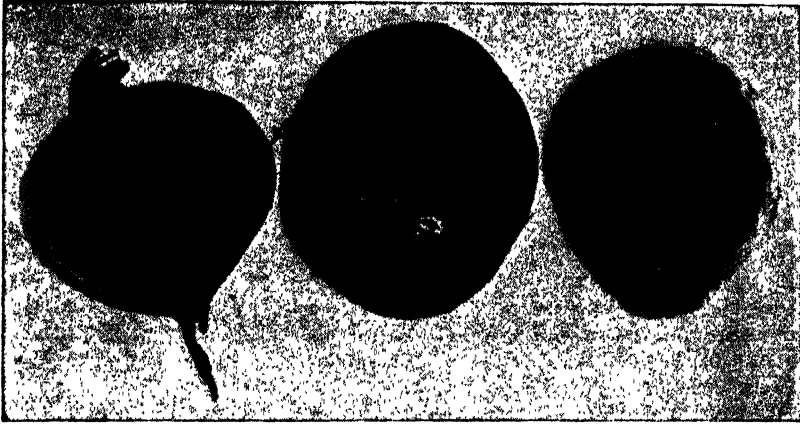


Fig. 2. When the internal corky area breaks through the surface of the beet, an external canker is the result.

The sorting of the beets is an expensive and wasteful procedure. Some of the affected beets may be discarded in the field as the corky areas when very close to the surface, may break through the epidermis and cause surface cankers like those shown in Fig. 2. When the corky areas are concealed below the surface, it is possible to detect them only by sorting the slices at the time of packing. This is a slow task which greatly reduces the factory output. There is also the danger that some of the blackened tissue will not be detected by the sorter and appear in the finished product.

Severe losses from this internal breakdown of canning beets were



Fig. 3. Twisted, non-symmetrical leaves with cross-checked petioles are symptoms of boron starvation. These symptoms in canning beets are very similar to those obtained in sugar beets.

experienced in New York in 1937, and a report issued in 1938 (1) stated that in greenhouse tests the trouble was greatly reduced by applications of 12 pounds of borax per acre.

Walker, Jolivette, and McLean (3), working in Wisconsin have also reported success in the use of borax as a control for this same physiological break down.

Leaf Symptoms

There are several symptoms of boron starvation which may be present in the leaves of the garden beet. One of these is in the color. As is the case with several other plants, the leaves of beets suffering from boron starvation may be of a deeper red color. This difference is not easily detected from the appearance of single plants but is noticeable if beets in borax-treated areas are compared from a distance with those in areas not treated with borax.

Another symptom, common to sugar beets as well as canning beets, is the occurrence of twisted and non-symmetrical leaves. The twisting of the leaves seems to be due to the slow development of one side of the leaf. This is shown in the beet plant pictured in Fig. 3. In the same picture is illustrated a leaf petiole symptom of boron starvation. On the upper or concave side the petiole cracks and takes on a characteristic cross-checked appearance. This is also a very common symptom in both sugar beets and mangels.

The occurrence of a large number of small leaves is also indicative of boron starvation. In the growth of a normal beet, new leaves continue to develop from the center of the crown and the oldest leaves, after reaching maturity, drop off from around the outer edge of the crown. When a beet is suffering from boron starvation the starting of new leaves continues, possibly at a stimulated rate, and the leaves become stunted or they may die long before reaching normal size.

Experimental

In addition to describing and presenting pictures of the symptoms of boron starvation it is the purpose of this article to present some of the results of greenhouse and field experiments which were conducted to study the value of borax as a control for the abnormalities which have been described.

Greenhouse

Garden beets were produced in pot cultures of Thomas sandy loam, a soil highly alkaline (pH.7.5), high in active calcium (54.75 m.e. per 100 grams of soil), and containing 14.01% organic matter. This is the kind of soil on which boron starvation is likely to develop in several crops. Duplicate cultures were treated with a complete nutrient solution exclusive of boron and these were compared with cultures receiving 10 pounds of borax per acre in addition to the complete nutrient solution. The borax was applied in solution and mixed with the soil. Three plants were grown in each pot.

Results—As indicated by the beets shown in Fig. 4 and the data presented in Table 1, growth was greatly stimulated by the borax.

The yield of roots was increased from 2.5 to 7.3 grams and the tops from 7.9 to 14.9 grams per pot as a result of the 10-pound application,



Fig. 4. Canning beets grown in Thomas sandy loam soil
(Left) No borax.
(Right) 10 pounds of borax per acre, mixed with soil.

Top symptoms of boron starvation were clearly evident in the plants from the control cultures. The plant shown in Fig. 3 was grown in this experiment.

Field

During the season of 1939, field experiments were conducted on three fields near Ellsworth, Antrim County. Two of the fields were on Emmet sandy loam and the third was on Bergland loam. Borax was applied, at rates of 10, 20, 30, and 40 pounds per acre, mixed with 2-12-6 fertilizer. Treatments were replicated four times in randomized blocks. The fertilizer, containing the borax, was drilled deep with a grain drill before the beets were planted.

Results—The data presented in Table 2 show that borax did not affect the yields of canning beets in the experiments conducted in 1939. This may have been due to lack of uniformity in the soil on which the experiments were performed. Although an attempt was made to select uniform soil areas, the large differences required for significance indicate a considerable error in this respect.

Despite failure to show differences in yields as a result of borax applications, the experiments showed that borax was very effective in

Table 1. The effect of borax on the yield of canning beets grown in pot cultures of Thomas sandy loam soil.

Treatment	Yield in grams per pot (Average of two)	
	Roots	Tops
Nutrient solution without borax	2.5	7.9
Nutrient solution with borax	7.3	14.9

Table 2. The effect of borax on the yield of canning beets in 1930.

Treatment*	Yield in tons per acre (Average of four plats)		
	Emmet sandy loam DeYoung farm	Bergland loam Elzinga farm	Emmet sandy loam Herres farm
No borax (control).....	9.30	7.55	10.51
10 pounds borax.....	8.81	8.50	11.49
20 pounds borax.....	9.52	7.37	10.91
30 pounds borax.....	9.33	7.18	11.51
40 pounds borax.....	9.73	8.31	10.72
Difference required for significance.	2.02	1.13	2.05

*All plats received 150 pounds per acre of 2-12-6 fertilizer. The borax was applied in the fertilizer mixture.

reducing the number of beets which had to be discarded because of blackened or corky tissue. According to the data reported in Table 3, an application of 10 pounds of borax per acre on the DeYoung farm reduced the number of unsound beets from 52.7% to 19.7%. Heavier applications did not further reduce the percentage on this field.

On the other sandy loam field, Herres farm, 10 pounds of borax lowered the percentage of unsound beets from 33.7 to 23.3, but it required 20 pounds to reduce the figure enough to show significance. This soil is higher in organic matter than is the DeYoung soil. It has been

Table 3. The effect of borax as a control of internal breakdown of canning beets in 1939.

Treatment**	Per cent of beets showing internal breakdown (Average of four plats)		
	Emmet sandy loam DeYoung farm	Bergland loam Elzinga farm	Emmet sandy loam Herres farm
No borax (control)	52.7	31.3	33.7
10 pounds borax.....	19.7*	32.9	23.3
20 pounds borax.....	26.7*	26.2	18.4*
30 pounds borax... ..	25.4*	12.4*	17.5*
40 pounds borax.....	17.3*	14.9*	12.1*
Difference required for significance.....	20.5	12.9	11.4

*Significantly less than control.

**All plats received 150 pounds per acre of 2-12-6 fertilizer. The borax was applied in the fertilizer mixture.

shown by some other work at this station that boron availability is inversely correlated with percentage of soil organic matter.

Another factor which affects boron availability is clay content. On a heavier soil, applied borax is more likely to be changed to an unavailable form than it is in a sandy soil. This proved to be the case on the Elzinga farm. The soil on that farm is not only higher in percentage of organic matter but also in clay content. The data show that on this farm it required 30 pounds of borax to reduce significantly the percentage of beets showing internal breakdown. By this rate of application the percentage was reduced from 31.3 to 12.4.

Discussion

A study of the data obtained in these field experiments shows that internal breakdown control was not so complete as might be expected. In the case of sugar beets, it has been possible to eliminate almost completely symptoms of boron starvation by either broadcast or row applications of borax (2). It seems that it should be possible to do this with garden beets. There is a possibility that the rates of application were too small, but it hardly seems likely since there were no further reductions, once the point of significance was reached, in the percentage of unsound beets by larger applications of borax. It seems likely, however, that better results might have been obtained with a different method of application. Broadcasting or drilling to a shallow depth with subsequent harrowing to mix the borax with the soil might be better than deep drilling without subsequent tillage. With deep drilling in bands 7 inches apart there is considerable possibility that a plant as small as a garden beet might grow between the bands of borax and not receive a sufficient quantity of borax until too late to prevent internal breakdown.

The placement of the borax in the row, either directly with the seed, in a band close to the side of the seed, or below the seed would probably give better control than would any form of pre-planting application. This has been the case with sugar beets. Care must be exercised in making application directly with the seed to avoid injury to germination. In the case of sugar beets only slight or occasional injury has been experienced with 10-pound per acre applications in contact with the seed, but no data are yet available from which to make recommendation regarding row application of borax for canning beets on Michigan soils. Until more experimental results are available it is perhaps advisable to depend on pre-planting applications of borax for this crop, unless the planter is equipped to place the borax in a band separate from the seed.

Summary and Conclusions

Internal breakdown of canning beets, an abnormality which is caused by a deficiency of available boron in the soil, has been the cause of considerable financial loss among Michigan beet growers and cannery during the recent years.

During 1939, greenhouse experiments were performed on Thomas sandy loam soil and in the field on Emmet sandy loam and Bergland loam to determine the value of borax as a control for this abnormality and to furnish information as to the quantity of borax which should

be applied on different soils. From the experiments performed the following results were obtained.

1. Certain abnormalities of canning beets such as the presence of black, corky areas within the root tissue, surface cankers on the roots, an intensified reddening of the leaves, twisted and non-symmetrical leaves, cross-checked leaf petioles, and numerous small leaves may be considered as symptoms of boron starvation.

2. An application of 10 pounds of borax per acre, mixed with Thomas sandy loam soil in pot cultures greatly increased the yields of roots and tops.

3. Borax applied in the field did not increase the total yields of canning beets but did increase the percentage which was marketable by reducing the number of roots showing internal breakdown.

4. The quantity of borax necessary to reduce significantly the percentage of abnormal beets varied from 10 pounds to 30 pounds on different fields. It is believed that these variations were due to differences in soil texture and content of organic matter.

5. Boron deficiency symptoms in canning beets were not so completely controlled by applications of borax as have been similar symptoms in sugar beets. It is believed that better results may be obtained with some different method of application of the borax. More experimental work is necessary before recommendations may be definitely made regarding rates and methods of borax applications for canning beets. Attention is again called to the fact that the data reported in this paper are the results from one year of experimentation and should be so regarded.

References

1. Borax for physiological breakdown of beets. New York State Agr. Exp. Sta. (Geneva) 57th Ann. Report. June 30, 1938. p. 33, 1939.
2. Cook, R. L. Borax as a control for heart rot of sugar beets. Am. Soc. of Sugar Beet Technologists, Proceedings, 1940 (in press)
3. Walker, J. C., Jolivette, J. P., and McLean, J. G. Internal black spot of canning beets and its control. Canning Age, Dec. 1938.

A STUDY OF CORN MATURITY

H. C. RATHER AND A. R. MARSTON*
SECTION OF FARM CROPS

Ripe Corn Needed

The wide use of the hybridization method of breeding corn has resulted in the development of a large number of new varieties now available for general use. The corn grower's interest in these strains centers in their productivity, their potential superiority by way of up-standing stalks, strong healthy roots, ease of handling, quality of grain, and especially their adaptation.

*Special acknowledgment is due J. R. Duncan, Research Assistant in Farm Crops (retired), who supervised the field work incident to these studies up to Sept. 1, 1939.

In general, corn which requires a long growing season is larger and more productive than corn requiring a shorter season provided the later maturing corn has the opportunity fully to ripen. The seasons of 1938 and 1939, in Michigan's chief corn growing areas were exceptionally favorable for ripening corn. Best yields in the varietal trials of those two seasons were generally attained by hybrids normally too late for the areas in which they were tested. Every corn grower must weigh the importance of obtaining an entire crop of sound corn in the unfavorable season against the few bushels extra yield produced by the later varieties in the favorable season. Immature corn "caught" by frost is not merely reduced in yield; the entire crop is harder to handle, its keeping qualities in storage are inferior, and its palatability and feeding value are diminished.

Over a period of years best yields of quality grain are obtained with corn varieties that mature with safety yet use essentially all of the available average growing season.

Corn Development Measured

To determine what happens to corn as it approaches maturity, an experiment was carried on at East Lansing in 1938 and 1939, in which the development of the crop was studied. Further work, particularly in less favorable seasons should reveal additional information of value.

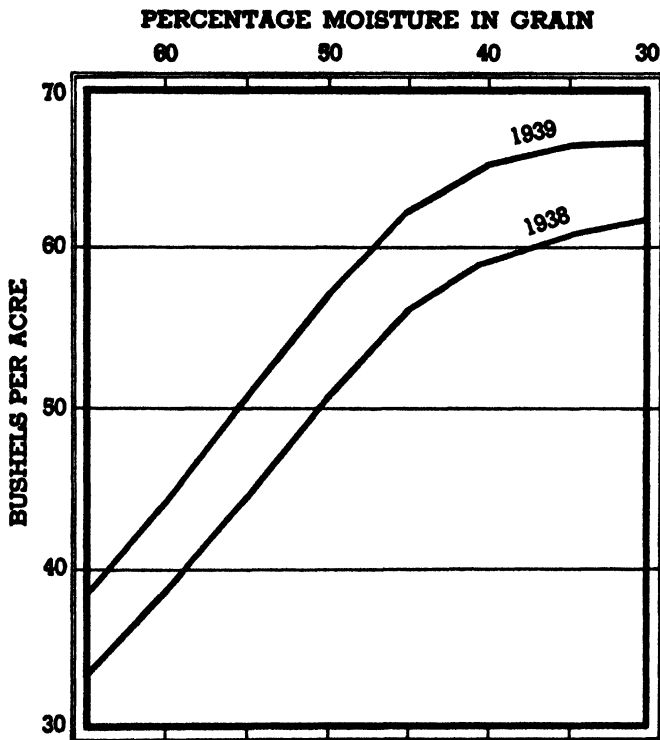


Fig. 1. Corn grain development in relation to moisture content, average of 10 varieties.

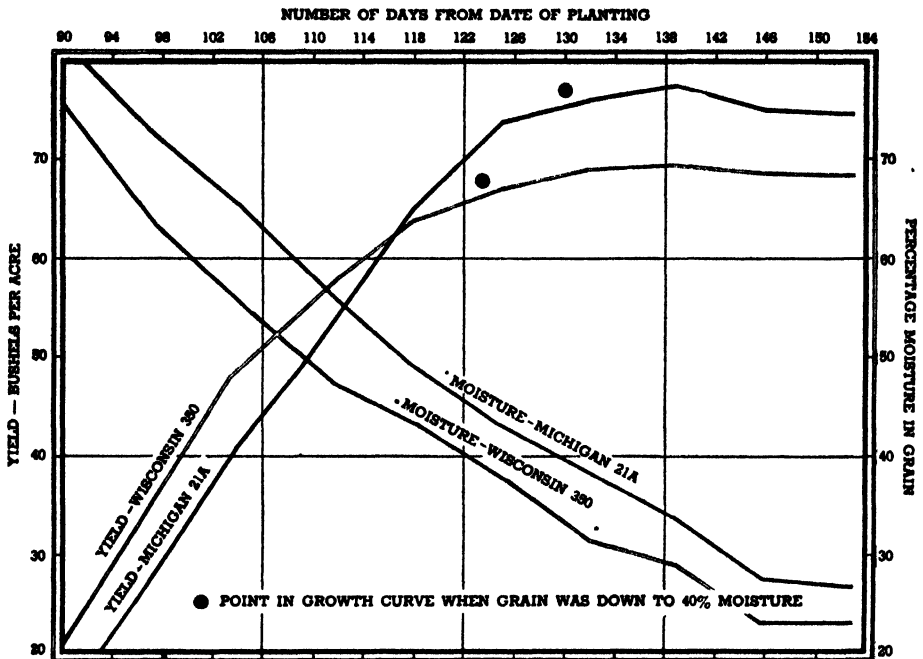


Fig. 2. Growth and moisture curves of Wisconsin 350, an early hybrid, and Michigan 21A, a later hybrid, in 1939.

However, the importance of a knowledge of corn maturity to growers and the consistency of the results obtained in the experiments which have already been conducted warrant a report of the findings which have been made thus far.

Ten varieties were used in this study, three of them open-pollinated, the rest hybrids. These 10 varieties were selected to provide a wide range in seasonal requirements. Minnesota Hybrid 402 and Northwestern Dent, the earliest of these lines have proved reasonably certain of ripening in northern Michigan; Indiana Hybrid 416, the latest corn used, is recommended by Purdue University for Northern Indiana.

To reduce the influence of soil variations, insofar as practicable, each variety was planted in 10 plats, the arrangement of the varieties in each series of plats being determined at random.*

Sample harvests were begun in mid-August before any of the varieties were mature and continued at weekly intervals well into October. The green and dry weight of the corn and the moisture content of stalks and ears were determined and provided the basis for calculation of acre yields. From these data, for the different harvest dates, curves indicating the rate and amount of growth were plotted. Also, graphs were made for each variety, indicating the rate at which moisture was lost from the grain as it matured and later dried out.

*Latin square arrangement.

Grain Slightly Below 40% Moisture When Growth Stops

Graphs are presented in Fig. 1 which show the average rate of grain growth for all varieties tested. These growth curves indicate that the grain contained somewhat less than 40% moisture before growth stopped. When the grain contained more than 40% water there was still translocation of dry matter into the kernels.*

In this respect, in both seasons, whether the corns were early or late and the yield high or low, the varietal performances were strikingly uniform. In Fig. 2 are presented growth and moisture curves for the season of 1939, of two hybrids which differed in maturity and productivity. Figure 3 is illustrative of the performance of one hybrid in the two seasons. It is of interest that part of the advantage in hastening corn maturity, which the season of 1939 held over 1938, was evident by the 90th day after planting, or by mid-August. The rest of the advantage came in early to mid-September when hot dry weather in 1939 hastened the ripening process.

Further evidence that corn is not fully developed until the grain contains not more than 40% moisture was obtained from a study of the shelling percentage of the different varieties in 1939. In all cases there was a material increase in shelling percentage as the corn ma-

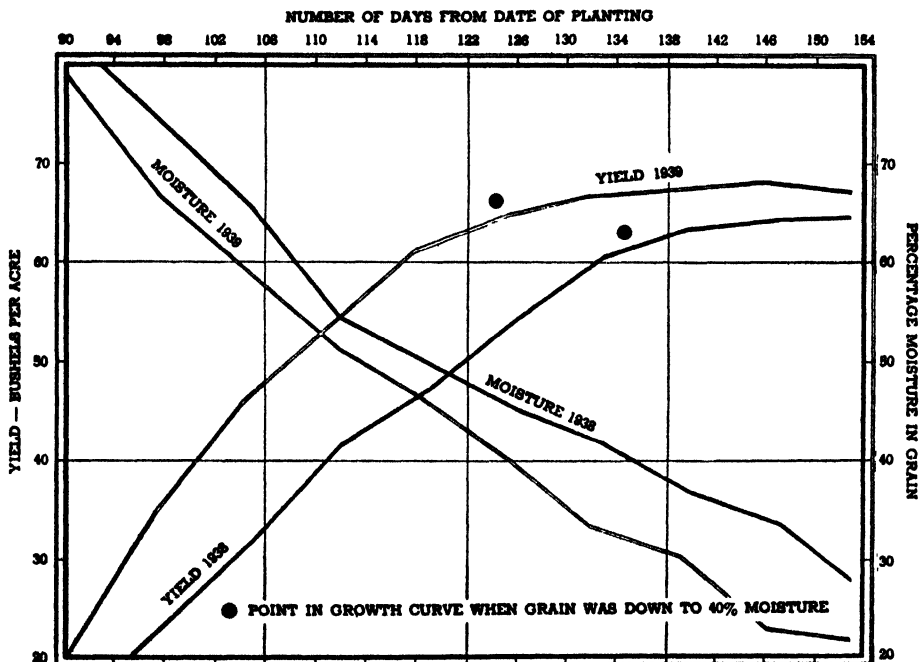


Fig. 3. Growth and moisture curves of Michigan hybrid No. 1218 in 1938 and 1939.

*Strictly speaking, the moisture content as determined in these studies was not exactly either grain or ear moisture. A representative ear sample was taken from each replication, weighed, dried until it would shell readily, reweighed, the moisture content of the shelled grain determined and the original moisture content calculated.

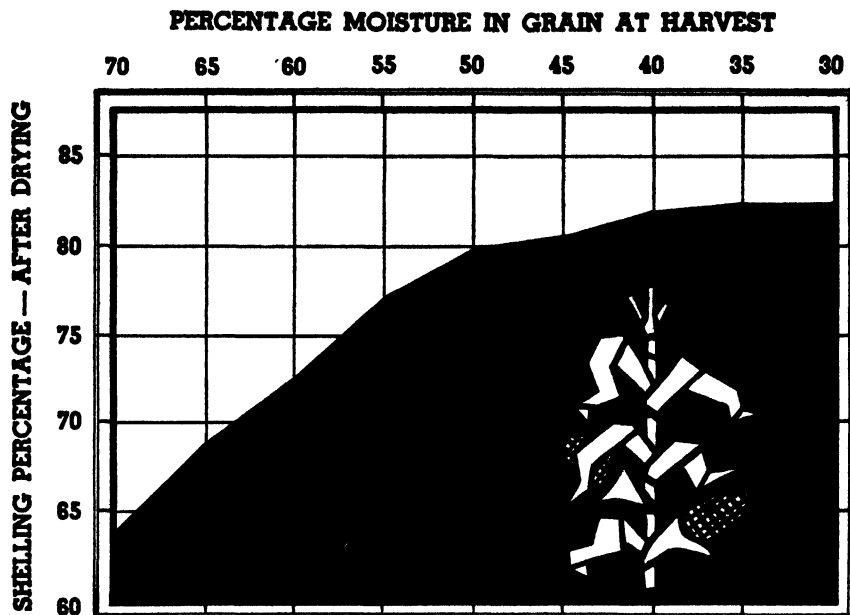


Fig 4. Average shelling percentage of 10 varieties at different stages of maturity—1939.

tured to 40% moisture on the standing stalk. Beyond this stage of development there was essentially no increase. The average shelling percentage of the 10 varieties at different stages of maturity is shown in Fig. 4.

Corn containing 40% moisture is well dented and the surface of the kernels is so hard it can scarcely be cut with the thumb nail. Obviously, such corn is still of too high moisture content for crib storage and further curing or drying beyond the ripening process is necessary before the corn should be husked, just as wheat cut with a binder must be further cured in the shock before being threshed. Ear corn, according to Wallace and Bressman,* is not safe for cribbing until the moisture content is down to 27%, and if the grain is to be stored as shelled corn the moisture content should not exceed 17%. Even a 17% moisture content is not safe if the shelled corn is to be held beyond mid-April, these writers observe, for during warm weather heating is more likely to occur.

Kiesselbach and Ratcliff,** in studies of frost injury to seed corn found that a moisture content of 15% or less is essential to avoid injury to germination should the corn be subjected to severe freezing. Official grades provide that U. S. No. 2 corn shall not contain more than 15.5% moisture.

*Wallace, Henry A., and Earl N. Bressman. Corn and Corn Growing. John Wiley & Sons, Inc., New York. 1928.

**Kiesselbach, T. A., and J. A. Ratcliff. Freezing Injury of Seed Corn. Neb. Agr. Exp. Sta. Res. Bul. 16. 1920.

Corn Harvested Too Early Yields Less

In sections of Michigan, where corn is cut and shocked prior to husking, it is not uncommon to find binder harvest being carried on when much of the grain is in the very early dent, soft dough stage. In this condition, the grain may contain 50 to 55 per cent moisture or more. Harvest at this stage is sometimes carried on unnecessarily early, as in late August when fully two or three weeks of good growing weather remain before the likelihood of a killing frost. The object of such early harvest is to obtain fodder of better quality.

In these trials as the grain matured from 50% to 40% moisture content there was a gain in yield, calculated on the basis of corn at 15.5% moisture, of from 5 to 12 bushels an acre.

Table 1 presents data showing this gain as Minnesota 402, an early; Michigan 1218, a medium; and Michigan 561, a late hybrid ripened from a 50% to 40% moisture. Figure 1 graphically shows the average change which took place with all varieties as they approached maturity.

Table 1. Gain in yield of an early, a medium and a late hybrid as the grain matured from a 50% to a 40% moisture content. Average for two years, 1938-39.

Hybrid	Yield in bushels per acre basis 15.5% moisture corn when grain actually carried—		Increase	No. days required to dry from 50% to 40%	Gain per day in acre yield during this period
	50% moisture	40% moisture			
Minn. 402 (early).....	46.5 bus.	51.6 bus.	5.1 bus.	12	.43 bus.
Mich. 1218 (medium) ..	51.5 bus.	63.2 bus.	11.7 bus.	14	.84 bus.
Mich. 561 (late).....	60.2 bus.	72.2 bus.	12.0 bus.	16	.75 bus.

Growers who pick their corn from the standing stalk are unlikely to make the mistake of harvesting the crop before the maximum development permitted by the season and variety has taken place. Their chief concern in this respect is to plant a variety with the right maturity characteristics.

Immature Corn Lower in Quality

The importance of growing corn, whether hybrid or open-pollinated, which will attain a low moisture content before frost is emphasized by comparisons made at the Ohio Agricultural Experiment Station by W. L. Robinson* in which both hybrids and open-pollinated varieties were studied as feed for hogs. The more palatable corns in these trials proved to be those which were lower in moisture, and when these more palatable corns were withdrawn consumption dropped.

"In nine out of ten comparisons," states Robinson, "the pigs that received the drier corn, regardless of whether it was hybrid or open-pollinated, ate more feed daily a head than those that received the corn that was higher in moisture. Thus, the comparisons indicated that palatability and low moisture content in the corn were associated Apparently maturity or dryness and discernible characteristics of quality are reasonably reliable indexes of feeding value in corns".

*Robinson, W. L. Will your hogs do better on hybrid or open-pollinated corns? The Ohio Farmer. Vol. 184, No. 7. 1939.

Silage Corn Should Approach Maturity

Corn development has an important bearing on harvest of the crop for silage as well as grain. Many growers plant very late varieties for silage purposes and put the corn into the silo when the grain is in the milk stage and contains 65 to 75% water. Of course, the corn must be high enough in water to pack well in the silo and to insure proper fermentation. Beyond this feature interest should be in the acre yield of dry matter and in quality—cows can get water from the tank.

In general, all varieties used in these studies attained nearly their maximum yield of total dry matter when the grain had just nicely dented, was still in the medium soft dough stage, and contained about 50% water (see Fig. 5). With the grain at this stage of maturity, the stalks still contained 72 to 75% water, so the total moisture in the plant was ample for the preservation of good silage. If harvested too late there is a loss in total dry matter because of disintegration of the stalks and leaves.

Big, moderately late varieties may be satisfactory for silage provided they are harvested late enough for the grain to develop into the early dent stage. If the silo must be filled by September 1, a variety which would normally be fully mature by September 15 should be preferable. The extremely large and late varieties, which often

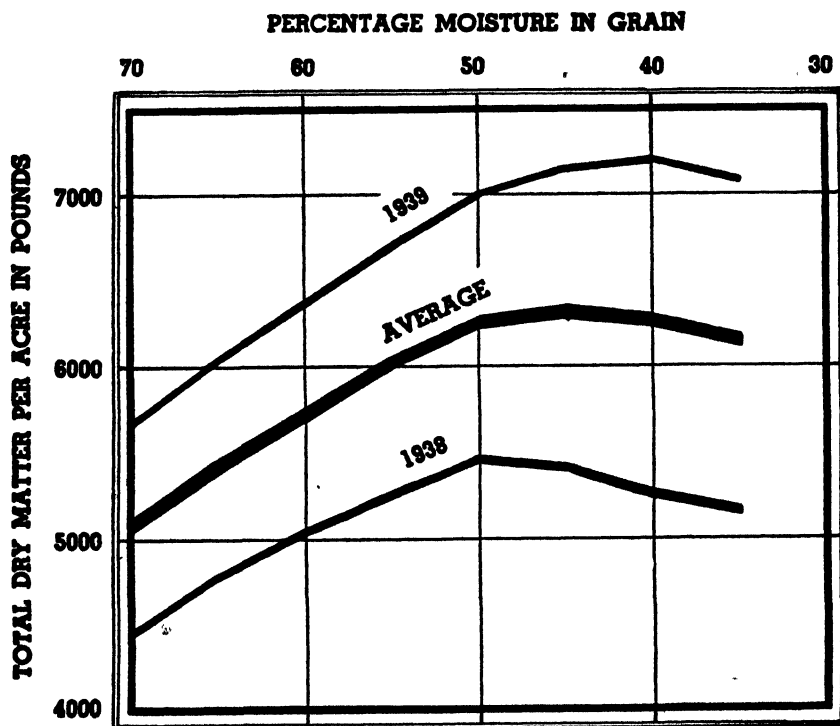


Fig. 5. Development of the total dry matter in corn in relation to the moisture content of the grain. Average of 10 varieties in 1938, eight in 1939.

**Table 2. Comparison of an early and a moderately late hybrid for silage.
Average for 1938-39.**

Variety	Silage yield—tons per acre	Condition of kernels	Percentage water in grain	Total dry matter per acre	Dry matter per acre in ears
		(A) If silo had been filled September 1			
Michigan 1218	9.0	Early dent	55%	5425 lbs.	2604 lbs.
Indiana 416	10.9	Milk	65%	6490 lbs.	2336 lbs.
		(B) If silo had been filled September 12			
Indiana 416	11.0	Early dent	55%	7010 lbs.	3365 lbs.

fail to get beyond the late milk stage by silo filling time are high in water and low in grain.

This is illustrated by a comparison of the development of Michigan 1218 and Indiana 416 at East Lansing, as averaged for the two years, 1938 and 1939.

By September 1, Michigan 1218 produced less silage, (green weight) per acre, and less total dry matter, but actually more grain than did Indiana 416. However, by delaying the harvest of Indiana 416 about two weeks the total tonnage of silage remained unchanged, but dry matter and grain were markedly increased and this hybrid was in excellent condition to make good silage.

Indiana 416 probably represents as late a variety as should be used for silage at East Lansing, its development being abnormally early in 1938 and 1939. In many seasons silo filling time with this hybrid would be during the frost period. A corn intermediate between Indiana 416 and Michigan 1218 should prove generally more satisfactory for silage than either of these two in this locality, for Michigan 1218 is slightly too early and small. Indiana 416 is too late for grain at East Lansing and generally throughout Southern Michigan.

Maturity Designation by Days is Unreliable

If corn must be down to not more than 40% moisture before it can be considered ripe and ready to cut, and, of course, much drier than this before it can be cribbed or marketed, an important consideration is the time required for the grain to attain this condition. It has not been uncommon to designate corn hybrids and varieties by a certain number of days, for example, 90-day, 100-day, 110-day. The implication is that the strain will, on the average, mature in the designated number of days. This designation has been interpreted rather broadly. In one case a 90-day corn was described as one which in 90 days from the time the seedlings emerged from the ground the grain would be reasonably well dented. In another case, a 100-day hybrid was said to be one which would be ripe in 100 days from the time the corn was up but only the good corn growing days were counted. The general interpretation among Michigan corn growers is that a 100-day corn should, on the average, be ripe in 100 days from the day the corn is planted. In this respect, practically all day designations have been grossly misleading.

Table 3. Comparative time required for corn varieties to reach maturity at East Lansing, Michigan. Planted May 12, 1938; May 13, 1939.

Variety	Number of days from date of planting until the grain was down to:					
	60% moisture		50% moisture		40% moisture	
	1938	1939	1938	1939	1938	1939
Northwestern Dent.....	102	96	110	106	126	115
Minnesota 402.....	106	96	112	106	129	116
Wisconsin 350.....	104	100	114	110	134	123
Michigan 1218.....	109	104	118	114	136	126
Pickett.....	109	103	117	112	136	123
Wisconsin 606.....	113	109	126	117	140	129
Duncan.....	110	108	125	117	143	127
Michigan 21A.....	—	109	—	118	—	131
Michigan 561.....	115	111	126	121	147	132
Indiana 416.....	117	113	135	122	150	136

The number of days from the time a corn is planted until the grain is ripe varies widely with environment as well as with inheritance. One of the most important considerations is the temperature during the growing and ripening season. Time of planting also has an important influence on the number of days required for corn to reach maturity.

Table 3 shows the number of days from date of planting required at East Lansing in 1938 and 1939, for the corns in this development study to reach certain specified moisture contents.

Although, in these trials, Northwestern Dent and Minnesota 402 have proved earlier than many of the so-called 90-day corns, these varieties have not even come close to maturity in 90 days at East Lansing. In fact, in trials in Otsego County, an area in which these varieties are grown rather than under the warmer conditions prevailing at East Lansing, approximately 140 days were required for them to reach maturity in 1939, whereas they reached this point in 116 days at East Lansing.

A good idea of the wide variation in time required for corn to reach maturity at different locations was secured from our 1939 over-state trials. In each of these trials the moisture content of each variety was determined at four different times as the corn approached maturity. Thus, it was possible to make a close estimate of the number of days from planting until the grain of each was down to 40% moisture. As an average, a group of 45 varieties matured 9 days earlier in Monroe County than they did at East Lansing; 41 varieties likewise matured 9 days earlier in St. Joseph County than at East Lansing, indicating that 1939 environmental conditions affecting maturity were essentially the same in the Monroe County trials as in those conducted in St. Joseph County. Twenty-three varieties tested both at East Lansing and in Saginaw County, near Chesaning, showed no material difference in time required to reach maturity, but 20 lines tested in Huron County and at East Lansing required, on the average, 8 days longer to reach maturity in the Huron County trials. Fifteen varieties required fully three weeks longer to reach 50% moisture content in the Otsego trials in Northern Michigan than they did at East Lansing and

most of them were not down to 40% moisture by harvest time which took place 143 days after planting, although several which failed to do so were described as 90-day hybrids.

Designation by any given number of days not only is unsatisfactory as varieties are moved from place to place but fails by a wide margin to describe accurately the maturity requirements of a particular variety in one place but for different seasons. The nine varieties which were in the development studies at East Lansing in both 1938 and 1939 matured, on the average, 13 days faster in 1939 than they did in 1938. Thus, no system which would designate a corn variety by any given number of days is at all accurate from place to place or from season to season, and such designation leads only to misunderstanding.

It is altogether probable that the only feasible way to establish the adaptation of a new line of corn is to test it thoroughly and carefully over a period of years in comparison with corns of known adaptation. If it proves to be of superior merit its use is warranted in areas where varieties of similar adaptation have proved their dependability.

Varieties Using Full Growing Season Yield Most

When seasonal conditions are such that corn has opportunity to mature fully there is a striking relationship between the time required for a variety to reach maturity and its yield. This, of course, does not preclude the development of relatively early hybrids of exceptional vigor which will out-yield some less worthy later hybrids. However, with hybrids of comparable merit in their respective maturity classes it may generally be said that the longer the required growing season the greater the yield, again with emphasis on the proviso that seasonal conditions must be such as to give the later maturing corn the opportunity to ripen. This relationship is shown in Table 4.

Of the corns used in this study, the open-pollinated varieties were not included in Table 4, because they are inherently less productive than the hybrids of similar maturity. The seasons of 1938 and 1939 were warm enough and long enough at East Lansing to mature Indiana 416, a late hybrid, but in many seasons the growing of a corn as late as Wisconsin 606 proves hazardous here. Varietal tests conducted in Michigan in such favorable seasons as these two give misleading conclusions as to the relative merit of varieties unless careful consideration is given to relative maturity and only lines which are similar in this respect are compared.

Table 4. Relationship between required length of growing season and yield of the hybrids included in the 1938 and 1939 development studies.

Variety	Average number of days from planting to maturity—1938-1939	Average yield, bus. an acre basis 15.5% moisture 1938-1939
Minnesota 402.....	123	53.5
Wisconsin 350.....	129	64.0
Michigan 1218.....	131	64.3
Wisconsin 606.....	135	68.5
Michigan 561.....	139	71.4
Indiana 416.....	143	74.2

When conditions are less favorable for the ripening of corn the difference in time of maturity between varieties tends to increase. For example, there was, on the average, only 8 days difference between Minnesota 402 and Michigan 1218 for the years 1938 and 1939 at East Lansing. However, in the Otsego County trials, about 200 miles north of East Lansing, there was 15 days difference. A variety which barely ripens in a favorable season, as was the case with Indiana 416 at East Lansing in 1939, is likely to be far from maturity when frost comes in the unfavorable season. There is every reason for a corn grower to choose varieties which mature with safety in the average season.

Summary

The development of 10 varieties of corn, including both open-pollinated and hybrid lines, was studied at East Lansing in 1938 and 1939.

Yield of grain at different stages of maturity and likewise shelling percentage indicated that corn is not ripe—that is, not through growing—until the grain contains not more than 40% moisture.

Maximum yield of dry matter in condition to harvest for silage did not occur until the grain had begun to dent and contained about 50% moisture. Total dry matter yields decreased after the grain had fully matured, owing to disintegration of the stalks and leaves.

Despite the use of certain very early varieties in these trials, there were no 90-day nor 100-day corns. The number of days from planting until the grain was down to 40% moisture varied widely from place to place and season to season. Designation of the maturity of a variety by any given number of days proved most unreliable. Adaptation can best be determined by comparison with established varieties.

Based on the above considerations, the following recommendations are indicated:

1. With respect to maturity, choose new varieties of corn only after they have been thoroughly compared with varieties of known adaptation. Avoid placing reliance on the superior yield of late varieties in tests conducted in unusually favorable seasons.
2. For grain, choose varieties that use as much as possible of the normal growing season, with a reasonable margin of safety to avoid serious losses in unfavorable seasons.
3. Do not cut corn for grain until the moisture content of the grain falls below 40%, in which condition the kernels are thoroughly dented and hard. When the corn is husked and cribbed the moisture content should not be more than 25% to 27%. U. S. No. 2 corn shall contain not to exceed 15.5%.
4. For silage, choose the most productive variety that will normally reach the early dent, (soft to medium dough), stage by silo filling time and harvest the silage crop as nearly as possible with the grain at this stage of development. At this stage the grain should contain 50% to 55% moisture, and the stalks about 75%.

BULLETIN REVIEWS

Spec. Bul. 301—Michigan Tax Trends as Related to Agriculture.—

Cline, D. C.—Major changes in state and local taxation are first shown for the state as a whole. Trends since 1900 in total taxes annually levied on general property and the assessed valuations and the average tax rate in Michigan are indicated. The composition of the state and local tax structure, the yields of the various taxes and the amount and nature of state payments to local units of government are shown for the years 1913, 1930, and 1938.

For a group of 200 selected agricultural townships, the total property tax levies, assessed valuations and average tax rates in 1938 were compared with those in 1930. A constitutional amendment adopted in 1932 limits property taxes to 15 mills per dollar of assessed valuation in townships and certain cities. The changes in property taxation between 1930 and 1938 in the 200 townships were compared with those for the entire state, the group of 11 cities subject to the 15-mill limit and the group of 5 largest cities not subject to the 15-mill limit. The average tax rate per \$1,000 of assessed valuation in these townships dropped from \$26.10 in 1930 to \$10.88 in 1938. The total of all taxes levied on property in the 200 townships in 1938 was 67 per cent less than in 1930 and 26 per cent less than in 1913. Half of the reduction since 1930 was the result of shifting the support of highways almost entirely to the motor taxes. One of the six sections of the study is devoted to rural highway finance. Another compares the trend of farm taxes in relation to farm values in Michigan since 1912 with trends in the east north-central group of states and in the United States as a whole. (88 pp., 7 tables, 35 figs.)

Spec. Bul. 302—The Lansing Region and its Tributary Town-Country Communities.—

Thaden, J. F.—This bulletin is a study of the hardware, banking, newspaper, rural mail-delivery, clothing, and high school centers and communities in the counties of Clinton, Eaton, Ingham, Ionia, Livingston, and Shiawassee, the extent to which various service areas coincide, the determination of a composite community boundary and the extent of its coincidence with township and county boundaries, and of changes of population since 1880; also a study is made of Lansing's zone of influence, the gradual change in agricultural and sociological characteristics in successive townships out from Lansing, and a comparison of those patterns in the Lansing region with the trends in the Flint and Grand Rapids regions.

With the coming of automobiles, good roads, and commercial agriculture, the village and its tributary area have become increasingly interdependent, and likewise has Lansing and its tributary communities become more and more interdependent. With increasing distance from Lansing, township by township, there is a gradual and consistent change in size of farm, percentage of land in farms operated by tenants, and unoccupied farm dwellings, and on the other hand a gradual decrease

in percentage of farm operators working for pay or income not connected with their farm, in the number of days such farmers worked at non-farm activities, in value of farm, and in proportion of farmers who were non-farmers five years ago. (50 pp., 12 tables, 14 figs.)

Tech. Bul. 169—"Thin Wood" Pruning Considered from the Standpoint of Photosynthate Production.—Pickett, B. S.—In a study of net accumulation of the products of photosynthesis, as measured by increases in dry weight, it was found that the leaves of thick, stocky apple branches are more efficient food manufacturing organs than those of weak, slender branches (typical "thin wood") in the same trees. These differences appear to be great enough to account in large measure for the difference in performance (flowering and fruit development) of the two types of wood. Corresponding differences were found in the amount of light ordinarily reaching the leaves of slender and of stocky wood. In reality, therefore, the unsatisfactory production of "thin wood" is an effect of limited light supply. (20 pp., 6 tables, 4 figs.)

Tech. Bul. 170—The Relation of Nutrition to the Development of Necrotic Enteritis in Swine.—Davis, G. K., Fræman, V. A., and Madsen, L. L.—In experiments covering three successive years, young pigs, fed in studies to determine the effect of different grains upon the pork carcass, developed necrotic enteritis. Results were obtained indicating that this disease may be due to a nutritional deficiency.

Various supplements were tried out to test their effect in the prevention and cure of necrotic enteritis. The results indicate that pigs receiving barley rarely developed an intestinal disorder, although running in the same pens with sick animals. The largest number of cases of necrotic enteritis developed in pigs receiving corn, with fewer cases developing in pigs receiving wheat and oat groats.

Supplements of fresh liver, yeast and nicotinic acid were most effective in preventing and curing the disease. It is suggested that necrotic enteritis in swine may be the result of a deficiency of nicotinic acid, accompanied or followed by an intestinal invasion by the organism *Salmonella choleraesuis* and possibly other organisms. (23 pp., 4 tables, 6 figs.)

JOURNAL ARTICLE ABSTRACTS

Pneumonyssus Canium, N. Sp., A Mite from the Frontal Sinus of the Dog.—Chandler, W. L. and Ruhe, D. S.—*Jour. of Parasitology.* 26 (1): 59-70. 1940. (Jour. Article No. 302, n. s., from the Mich. Agri. Exp. Sta.) In 1937 during an autopsy on a bulldog, some internal mites were recovered from the frontal sinuses and were reported to be present in numbers. These mites were recognized as being dermanyssid mites belonging to the subfamily Halarachninae. Because of the peculiar location of these mites, the writers decided to investigate this infestation further and, although it was two hours before the thorough examination could be made, several mites were still present in the frontal sinuses, and a few were found in various parts of the body cavity. Only

one, however, was found in the lung. There were not severe pathological lesions although evidence of irritation of the mucosa of the sinuses and a general systemic disturbance was probably due to the presence of these mites. The writers therefore decided to attempt a classification of this mite, found it to be a new species and so described it.

Some Observations on a Chemical Test for Pregnancy in Mares.—

Sholl, L. B. and Dersham, G. E.—*Jour. Amer. Vet. Med. Assoc.* **95**: 507-508. 1939. (Jour. Article No. 358 n. s., from the Mich. Agri. Exp. Sta.) A modification of the Cuboni test is presented. Urine is filtered, treated with hydrochloric acid in a boiling water bath, extracted with benzene, and the benzene treated with sulphuric acid in a water bath. A positive sample, shows green fluorescence of the sulphuric acid layer. A table presents breeding dates, dates of tests, results of tests, results of physical examinations and subsequent histories of 17 cases. The test apparently is reliable in mares after 80 to 90 days of pregnancy, and is very inexpensive and simple.

Two Cases of Malignant Neoplasm in Dogs.—

Sholl, L. B., Langham, R., and Sales, E. K.—*Jour. Am. Vet. Med. Assoc.* **95** (448) 757-759. 1939. (Journal Article No. 366 n. s. from the Mich. Agri. Exp. Sta.) Two interesting cases of malignant neoplasm are presented, one a sarcoma and the other an osteogenic sarcoma. Blood examinations of the two dogs revealed marked anemia and leucocytosis. These two conditions are characteristic of malignant neoplasms. Illustrations and descriptions of the neoplasms are presented.

A Summary of 700 Autopsies on Sheep and Lambs.—

Sholl, L. B.—*Jour. Am. Vet. Med. Assoc.* **47** (6): 663-664. 1939. (Journal Article No. 367 n. s. from the Mich. Agri. Exp. Sta.) It is frequently asked what are the most important causes of deaths in sheep and lambs. In the article the author tabulates diagnoses on autopsies made during a period of 15 years. A total of 700 autopsies are tabulated under 128 diagnoses. Food intoxication and intoxications plus parasitism comprise 174 cases, or approximately 25 per cent. Parasitism and parasitism plus intoxication comprise 132 cases, or approximately 19 per cent. Third in order of frequency is pregnancy disease with 52 cases or about 7 per cent. Study of the list leads to the conclusion that feeding problems constitute the greatest single factor causing loss in sheep raising in Michigan. Parasitism holds second place.

Stiff Lamb Disease in Michigan.—

Sholl, L. B.—*Jour. Am. Vet. Med. Assoc.* **95** (448): 108-109. 1939. (Journal Article No. 369 n. s. from the Mich. Agri. Exp. Sta.) Though only 7 cases of stiff lamb disease were encountered in autopsies conducted at Michigan State College during 15 years prior to the spring of 1939, 15 autopsies were performed on such cases that one season and large losses were reported by both farmers and veterinarians. Studies of the factors leading to this disorder lead to the belief that low protein or lack of muscle dystrophy factors or both were responsible. Whole milk, to which gelatin and wheat germ oil were added, brought about recoveries in some severe cases. Creep feeding of lambs, using ground mixed feeds, is recommended with the hope that it will reduce further losses from this disease.

The Relationship Between the Cooked Flavor and Peroxidase Reactions in Milk, Skimmilk, and Cream.—Gould, I. A.—*Jour. Dairy Sci.* **23** (1): 37-46. 1940. (Journal Article No. 371 n. s. from the Mich. Agri. Exp. Sta.) A close correlation was found to exist between the temperature at which the cooked flavor appeared in milk and skimmilk and that at which peroxidase was inactivated as determined by the Storch and Guaiac tests. This relationship persisted both for momentary and 30-minute holding periods and suggested the possibility that the reducing system formed in milk simultaneously with the cooked flavor may itself be responsible for the negative peroxidase reactions rather than that the enzyme is inactivated. However, when cream was heated, the cooked flavor appeared at a lower temperature than in milk without affecting the temperature at which the peroxidase reactions became negative. Therefore, the correlation noted between the peroxidase reactions and the cooked flavor in milk appear to be a coincidence. Addition to the milk of relatively large quantities of ammonium and sodium sulphite, or glutathione, produced a typical cooked flavor without appreciably affecting the peroxidase reactions or the oxidation-reduction potentials. However, the treatment of the milk with hydrogen sulphide greatly lowered the pH of the milk and in addition prevented the appearance of a positive peroxidase reaction even in raw milk. This fact indicates that the hydrogen sulphide formed in milk on heating should not be overlooked when consideration is given to tests involving oxidation reagents.

The Use of Oxalated Blood in Cytological Studies.—Sholl, L. B.—*North Amer. Veterinarian.* **21** (4): 211-212. 1940. (Journal Article No. 373 n. s. from the Mich. Agri. Exp. Sta.) The author describes the method used in obtaining blood from the jugular vein and discusses preparation and use of anticoagulants. Oxalated blood has been found very convenient and satisfactory to use for red blood cell counts, white cell counts, differential leucocyte counts and hemoglobin determinations.

Pseudomonas Infection in Turkeys.—Stafseth, H. J., Mack W., and Ryff, J. F.—*Poultry Science.* **19** (2): 126-130. 1940. (Journal Article No. 379 n. s. from the Mich. Agr. Exp. Sta.) In the course of some examinations of sick turkeys an organism, belonging to the genus *Pseudomonas*, was isolated. It proved to be very closely related to the *Pseudomonas aeruginosa*, an organism which causes suppurative processes with blue pus in man and animals. The organism is described. It was found to be pathogenic for turkeys, chickens, pigeons, rabbits, guinea pigs, rats and mice. In poultry it caused a disease characterized by droopiness advancing to coma, twisted neck (2 chickens), wobbly gait, marked weakness, bluish discoloration of the skin, ruffled feathers and loss of appetite. Some birds had diarrhea with foul smelling, yellowish white, and sticky droppings. There was fever of 110° to 111° F. Most of the birds died in 48 hours after artificial infection. On postmortem examination, the birds showed slow coagulation of blood, mucous or hemorrhagic enteritis, petechial hemorrhages on serous membranes and grayish or yellowish spots or streaks on the liver. Some showed greenish discoloration of several visceral organs.

Streptococcic Infection in Dogs. II. Pathogenicity, "Acid Milk," Convulsions, Torticollis, Abscesses, Conjunctivitis and Skin Contami-

nation.—Stafseth, H. J.—*Jour. Am. Vet. Med. Assoc.* **96** (755): 230-235. 1940. (*Journal Article No. 380, n. s., from the Mich. Agri. Exp. Sta.*) Attempts at reproducing the disease in puppies and older dogs were unsuccessful. Nevertheless it is the view of the author, supported by British investigators, that certain streptococci are responsible for the manifestations covered in the title. No doubt predisposing causes of various sorts may pave the way for the infection. If our assumption is correct, streptococci are responsible for much disease in dogs. Staphylococci, streptococci and other organisms were isolated from the skin of dogs. Three common disinfectants, applied in the usual manner, proved to have little or no effect on these organisms. Therefore, greater care in applying disinfectants, prior to certain surgical procedures, is suggested. Further evidence is offered to support the idea that "acid milk" is due to infection and not to acid milk.

Availability of Manganese in Natural and Precipitated Manganese Carbonate.—Bandemer, S. L., Davidson, J. A., and Schaible, P. J.—*Poultry Science.* **19** (2): 116-125. 1940. (*Journal Article No. 385 n. s., from the Mich. Agri. Exp. Sta.*) Feeding experiments were conducted to evaluate the relative perosis-preventing capacities of natural (the ore, rhodochrosite) and precipitated MnCO_3 . Parallel equilibration experiments were carried out *in vitro* in H_2O or N/10 HCl, with and without the ration.

When fed to chicks, rhodochrosite failed to prevent perosis but the precipitated MnCO_3 protected against it. Decreasing the particle size of the ore from that retained by a No. 100 sieve to that remaining suspended in alcohol for 5 minutes was without effect in decreasing perosis. Equilibration experiments on these fractions demonstrated that the solubility of the ore increased with time, temperature and decreased in particle size, but the rate of solution was not so great as that of precipitated MnCO_3 . If suspensions of both carbonates having about the same particle size and manganese concentration were treated with N/10 HCl at room temperature, the precipitated MnCO_3 was completely soluble in a concentration which dissolved only half of the rhodochrosite.

Precipitated MnCO_3 prevented perosis at 30 p.p.m. Mn but rhodochrosite (passed No. 300 sieve) at levels of 30, 50, 75, 100 and 125 p.p.m. was unsatisfactory. On equilibration with acid, the soluble manganese of rations containing the ore was much less than of those supplemented with precipitated carbonate and did not seem to be correlated with the pH of the extracts.

Rhodochrosite, either roasted or dissolved in acid, and precipitated MnCO_3 with additions of known impurities of the ore, were effective, indicating that the manganese was satisfactory if available to the chick. Excess of certain mineral supplements which are known to be perosis-producing, decreased the soluble manganese from both carbonates, but the reduction was more pronounced with the ore. If both carbonates were in solution, this effect was less, with no distinction between the two.

Methods for the determination of manganese and the differentiation of rhodochrosite from precipitated MnCO_3 are given.

A Method for Calculating the Baume Reading of Condensed Ice Cream Mixes.—Larson, R. A., and Lucas, P. S.—*Jour. Dairy Science.*

23 (3): 229-244. 1940. (Journal Article No. 387 n. s., from the Mich. Agri. Exp. Sta.) Tests were made under controlled conditions to obtain a factor, which, when multiplied by the average specific gravity of the ingredients of a finished condensed ice cream mix, would give a predetermined Baume reading at which to draw the mix. Densities of the more common materials used in ice cream mixes were determined as follows: milk-solids-not-fat, 1.6129; sucrose, 1.6107; gelatin, 1.5384. Bailey's calculation for butterfat specific gravity was accepted. Pounds of each ingredient used in 100 pounds of mix was multiplied by its specific gravity, the amounts added, and divided by 100. When this result was multiplied by the factor 0.949, for the temperature range of 120-135° F. in drawing the mix, the result gave the desired specific gravity of the mix. This value was converted to Baume reading by standard formula. Results were within 0.2° Baume desired. Tables are given for this conversion. Factors affecting the reading are discussed and their group effects given.

Determinations of Chlorophyll and Carotene in Plant Tissue.—Petering, H. G., Wolman, W., and Hibbard, R. P.—Industrial and Engineering Chemistry, Anal. Ed., **12**: 148-151. 1940. (Journal Article No. 389 n. s., from the Mich. Agr. Exp. Sta.) Methods for the determination of chlorophyll and carotene are still of great interest to biochemists and plant physiologists because the older methods are long and tedious and the newer modifications of these leave much to be desired in accuracy and reproducibility. The determination of chlorophyll alone is not difficult, but the determination of carotene or both pigments has always been laborious.

This method employs a standard photoelectric colorimeter with suitable filters for the final pigment determinations. The pigments are extracted by grinding the tissue with sand and acetone. The extract is then made to volume and an aliquot is placed in the absorption cell of the photoelectric colorimeter for chlorophyll determination. A Corning No. 243 ST polished glass filter is used in combination with a Corning No. 396 ST filter to isolate a band of red light which is strongly absorbed by chlorophyll. Comparison of the colorimeter reading with a standard curve yields chlorophyll values directly. The yellow plant pigments do not interfere with this determination.

An aliquot of the extract is next refluxed with excess of finely divided barium hydroxide octahydrate. This causes removal of the chlorophyll. The mixture is cooled, filtered, and washed. The filtrate is then transferred to a separatory funnel, extracted with petroleum ether and the petroleum ether phase is washed free of solvents and xanthophylls. The carotene in the petroleum ether is then determined photometrically. A Corning polished glass filter No. 554 ST is used to isolate a spectral band which is strongly absorbed by carotene.

A method is outlined for correcting for any traces of chlorophyll which may interfere with the carotene determinations.

Food Intoxications in Sheep.—Sholl, L. B.—Jour. Am. Vet. Med. Assoc. **95** (448): 642-643. 1939. (Journal Article No. 394 n. s., from the Mich. Agr. Exp. Sta.) Sheep appear to be sensitive to sudden changes or to abnormal conditions in feeds. It has been the experience of some feeders that some times deaths are associated with long-continued

heavy feeding. Corn silage and corn fodder may sometimes cause much mortality and bean pods have caused losses in some cases. These losses are probably due either to spoilage or to improper balance in the ration. Losses are sometimes incurred when feeders are run in corn fields, due probably to spoilage, gorging or irregular eating. The author discusses the causes, symptoms, autopsy findings, diagnosis and treatment, with blood cytology and chemistry studies on 42 cases.

The Examination of Milk for Streptococci of Mastitis as an Indicator of the Streptococcus Infection of Bovine Mammary Tissue.—Bryan, C. S., Moore, G. R. and Campbell, J. H.—*Vet. Med.* **35** (3): 166-168. 1940. (Journal Article No. 405 n. s., from the Mich. Agr. Exp. Sta.) This study was undertaken to determine the efficiency of diagnosing streptococcus infection of the udder by examining the milk for mastitis streptococci, and to determine whether all cows harbor mastitis streptococci in their udders.

Sixty-seven of 94 cows were found to have streptococci in the milk prior to slaughter and the mastitis streptococci were found in the udder tissue collected immediately after slaughter. The presence of streptococci in properly collected milk samples was evidence that there was a streptococcic infection of the udder tissue. In 27 of the 94 cows, streptococci were not found in the milk prior to slaughter and the streptococci were not found in the udder tissue. Six of these cows were free of streptococcic mastitis on monthly tests for periods varying from 6 to 36 months prior to slaughter. The absence of streptococci in properly collected milk samples was evidence that streptococcic infection was not present in the udder tissue.

Two of the six heifers that had never lactated were found to be infected with streptococci of mastitis. The remaining four yielded no streptococci upon examination of the mammary secretion or tissue.

Rumen Digestion Studies.—Hale, E. B., Duncan, C. W., and Huffman, C. F.—*Proc. Am. Soc. An. Prod.* **32**: 389-393. 1939. (Journal Article No. 407 n. s., from the Mich. Agr. Exp. Sta.) Methods of studying rumen digestion in the cow were investigated and lignin ratios were found to be superior to iron ratios for ascertaining the digestibility of various nutrients in the rumen. The application of lignin ratios revealed that a very high percentage of the digestible nutrients of alfalfa hay was removed during rumen digestion. An increase in true fat in the rumen at the highest level of feeding was considered to indicate the synthesis of fat by rumen microorganisms. Lignin was apparently digested subsequent to its passage from the rumen. The reaction of the rumen was neutral or slightly acid and reached a maximum acidity about six hours after feeding.

The level of feeding alfalfa hay did not have any marked effect on digestion coefficients except that at the submaintenance level of nutrition there was a definite decrease in digestibility. Partitioning the carbohydrate fraction of alfalfa hay into lignin, cellulose and other carbohydrates was of much greater value in estimating the biological value of the hay than the method commonly used. An enzymatic method for determining crude fiber was equally superior. True fat values were of greater biological significance than ether extract values.

The Effect of Different Wrappings, Temperatures and Length of Storage on Keeping Qualities of Frozen Pork Chops.—Griswold, Ruth and Blakeslee, L. H.—32nd Ann. (1939) Proc. Am. Soc. Animal Production. (Journal Article No. 410 n. s., from the Mich. Agr. Exp. Sta.) Pork chops were frozen individually at -15° F. After freezing, the chops were prepared for storage with seven different materials and were stored at 0° , 5° and 15° F. Weights were taken before freezing, before storage, and after storage. The chops were wrapped in groups of four and stored for 60, 120 and 180 days. After storage the chops were cooked according to a standard method, sampled by a committee of four and scored according to the standard of the National Cooperative Meat Project.

Results show that wrappings had little effect on the palatability of the chops under the experimental conditions used, but had a decided effect on the moisture loss. Moisture-proof cellophane allowed less moisture loss and appeared to maintain brighter color in the pork chops than did any other material used. The palatability of the chops decreased and shrinkage increased as the storage period lengthened. Most of the chops were still edible after 180 days of storage, although the fat of some of the chops was rancid.

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Agricultural Experiment Station



East Lansing

Michigan

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**EDITED BY
V. R. GARDNER AND A. A. APPLGATE**

**CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION**

THE VICTOR TOMATO

A. F. YEAGER
SECTION OF HORTICULTURE

The Victor tomato originated from a cross between Allred, a variety introduced by the North Dakota Agricultural Experiment Station in 1937, and Break O'Day. Victor carries the determinate or self-pruning vine of Allred, much of its earliness and its uniform color, together with the smoothness of the Break O'Day. The fruits are somewhat flat, have a good depth of flesh, a desirable red color and resist crack-



Fig. 1. A fruiting branch of the Victor tomato, showing closely spaced clusters and determinate (self-topping) growth habit.



Fig. 2. A fruiting branch of the Earliana tomato, for comparison with Fig. 1.

ing. As is true with most determinate varieties, there is a tendency toward deficient foliage, leaving the fruit more exposed than is desirable late in the season. Despite this sparse foliage, sunscald is much less than might be expected.

Though there is a tendency toward roughness of the fruit late in the season at East Lansing, this is much less noticeable than with Earliana. The first fruits ripen with the first of the Earliana selections but during the first several weeks of ripening, a larger proportion of the crop is matured. In 1938 seeds sown May 25 began ripening their crop by the middle of August and matured all of it before frost. The market quality of the fruit may be judged by the fact that while this crop ripened at the same time as transplanted John Baer, Marglobe and other standard commercial varieties, purchasers preferred the fruit to the standard sorts.

In 1939 seed was distributed to many growers for a cooperative trial in various parts of Michigan and likewise to a number of agricultural experiment stations. For the most part the results were favorable, showing an early production as large or larger than the best Earliana

Name	Weight of Plant by August 15—lb.	Average Weight of Each Fruit—lb.
Victor.....	7 2	.215
Earliana (Morse's No. 498).....	6.8	.173
John Baer (Geneva).....	4.2	.176
Rutgers.....	2.0	.220

selections during the fore part of the season, with a much higher percentage of the fruit of marketable quality.

In a careful trial in the experimental plots at East Lansing in 1939 the results shown in the accompanying table were obtained. These represent averages of 20 plants for the other varieties taken from 4 blocks of 5 plants each distributed in various parts of the field. The Victor record is from 140 plants set in 28 places with 5 plants in each block. The seed was sown April 3 and the plants set in the field May 30 with a spacing of 3 x 6 feet. Morse's No. 498 was used as a check because it had been found in previous years to be one of the best Earliana types at East Lansing. The Geneva strain of John Baer likewise represents one of the best of its class.

It will be noted that all varieties produced comparatively low yields and that their fruits were small in size. This was the result of a very dry growing season with no irrigation being used.

The variety was named Victor in the autumn of 1939. Seed is being grown by commercial seed companies for introduction to the trade in 1941. Only small quantities for trial and limited seed stocks for increase

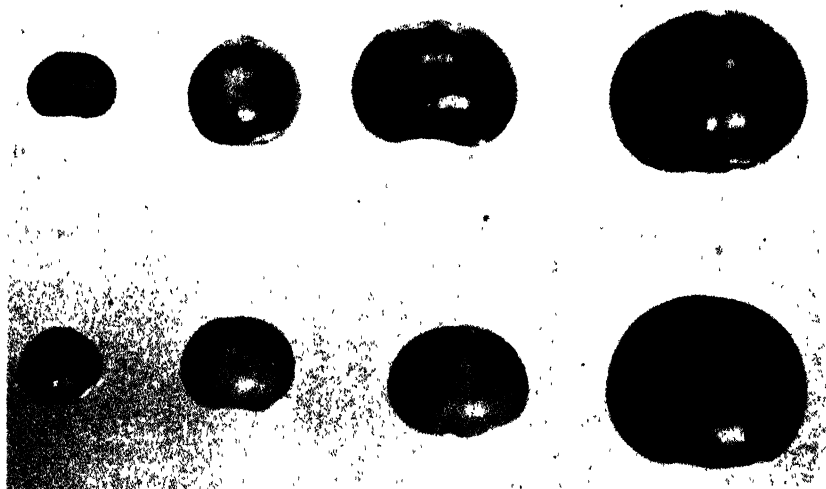


Fig. 3. Upper row shows fruits of the Earliana tomato in various stages of development. Lower row shows fruits of the Victor tomato at comparable stages of development. Note the uniform color and freedom from cracks in the latter variety.

are available at present. Victor is recommended for trial as an early market variety in Michigan. If it is used, the spacing between the plants should be less than for standard sorts. Probably 30 inches in the row with 4 feet between the rows would be sufficient. Under ordinary cultural conditions this variety should ripen almost all its crop before September 1; hence if tomatoes for late sale are desired, other later ripening sorts should be planted along with Victor to supply that demand.

RECORD OF PERFORMANCE IN SHEEP

C. L. COLE

SECTION OF ANIMAL HUSBANDRY

The selection of breeding sheep in the past has been based entirely on incomplete phenotypic selection. Usually selection has been made entirely on what has been visible to the eye. This has included those things which are generally conceded to be correct body and breed type for the particular breed being selected. This kind of selection has proved inefficient in the development of highly prepotent lines of breeding because the body and breed type of an animal give little evidence of such things as growth rate, fertility, longevity and economy of gains. All these qualities are necessary for complete phenotypic selection since they are a part of the animal's production.

In an experiment at the Michigan Agricultural Experiment Station, designed to measure the performance of sheep, the author has found some significant indications relative to type and production relationships. It is generally assumed by sheep men that because an animal is of correct type it is necessarily a good producer, and that there should be little difference in the productivity of ewes of comparable type and size.

A study of the 1939 gross income from each individual ewe in the College flock shows a wide range between individuals. The gross income was computed by taking the value of the lamb at 135 days and adding to that the value of 12 months growth of wool.

These comparisons were made in four different breeds and it is especially significant that the great difference is between individuals within the breeds rather than between different breeds.

In the Hampshires there was a range from a low of \$6.45 to a high of \$18.18 in gross income per ewe for the year. It is worth while to note that the lambs of these two ewes were sired by the same ram and both ewes and lambs were under the influence of the same environmental factors. These two ewes were comparable in type and were the result of careful selection on the basis of show-ring standards, over a period of 45 years.

In the Oxford breed the range was \$9.49 to a high of \$16.56. In this breed there was less range and a correspondingly greater uniformity in the income from individual ewes.

These figures show the great difference in growth rates of lambs within the breeds and indicate again that the important difference is between individuals rather than between breeds.

The average daily gain for all lambs of the various breeds for 1939 was about the same, for the Shropshires and Rambouillet being 0.451 and 0.465 pound respectively, with the Oxfords and Hampshires slightly higher, with 0.53 and 0.547 pound respectively.

There was just as great a range in degree of finish at 135 days as there was in daily gain and again the difference lies within the breed and not between breeds.

The results to date in this experiment strongly indicate that more emphasis needs to be placed on the actual production performance of the individual than has been done in the past.

SUMMER SPRAYS FOR CONTROL OF THE GLADIOLUS THRIPS

E. I. McDANIEL
SECTION OF ENTOMOLOGY

The gladiolus thrips (*Taeniothrips simplex*, Morr.) is the most important insect infesting gladiolus. Its wide distribution, the rapidity with which it breeds, the fact it is capable of wintering-over out-of-doors as well as on stored corms and that it maintains itself on a wide range of host plants, indicate that this species of thrips may continue to be a factor wherever gladioli grow.

Fortunately, where corms free from thrips are planted, a good crop of flowers can be harvested, provided suitable sprays are applied before the migratory infestation builds up to the critical point. Where thrips are present, sprays to be effective should be applied at intervals of a week or 10 days and following heavy rains—from the time the plants are from 4 to 6 inches above ground until the buds show color. If sprays are required after the plants come into bloom, cut all flowers within two or three days of opening before making the application.

Experimental work conducted by the Bureau of Entomology and Plant Quarantine,* as well as the results of investigations reported by various experiment stations indicate that sprays using tartar emetic for the killing agent and brown sugar for the attractant are superior to other combinations.

Various strengths have been tested, and further investigation is necessary to establish the proper dosage. Where 2, 3, or 4 pounds tartar emetic and 8 to 16 pounds brown sugar were used to 100 gallons of water a good control was effected. While the smaller dosage of tartar emetic killed the thrips present, the protection did not extend over so long a period as where a higher concentration was used. Both tartar emetic and brown sugar are soluble in water and mixing is

*Strong, Lee A. Report of the Chief of the Bureau of Entomology and Plant Quarantine. 1939. pp. 64-65.

facilitated when the proper dosage is dissolved in a small amount of warm water, then diluted to the desired strength. It is generally conceded that, under average conditions, it is desirable to use 4 pounds tartar emetic, 16 pounds brown sugar, in 100 gallons of water (in small batches, 2 ounces tartar emetic, 8 ounces brown sugar in 3 gallons of water). Under Michigan conditions the author believes the amount of sugar can be reduced one-half without lowering the efficiency of the spray and thus help to prevent any damage to the plants. The tartar emetic combination like the paris green formula in general use is most effective where applied as a fine mist. Though good coverage is necessary, stop spraying before the droplets unite and the spray "runs off."

Experimental work indicates that calcium antimony tartrate at the rate of 2 and 4 pounds plus 16 pounds of brown sugar per 100 gallons of water are nearly as effective, if not fully so, as the tartar emetic formula already recommended.

In 1939, both tartar emetic and calcium antimony tartrate were checked on experimental plots at Michigan State College in comparison with: (a) standard paris green, brown sugar formula, now in general use; (b) paris green 2 pounds, brown sugar 64 pounds, water 100 gallons; and (c) for small dosages, 2 level tablespoonfuls paris green, 2 pounds brown sugar in 3 gallons of water. Better quality flowers, less injury to the foliage, together with from 10 to 15 per cent more effective control of the gladiolus thrips, resulted from the use of either tartar emetic or calcium antimony tartrate, than did the use of the paris green formula.

Gladiolus thrips can be killed with a contact spray, but it is usually necessary to repeat the application three times at from 48- to 72-hour intervals. Nicotine sulphate 40 per cent, 1 pint to 100 gallons water, plus 4 pounds dissolved laundry soap, or 4 ounces sulphated alcohol spreader, when applied with a pressure spray rig giving 250-400 pound-pressure will reduce an infestation and often make it possible to harvest a good crop. On a small scale, where the spray is applied to plants on ornamental plantings instead of in the field, smaller dosages are desired and usually the application is made with a sprayer giving little or no pressure. Under such conditions, use 1 tablespoonful nicotine sulphate 40 per cent to a quart of suds or 1 ounce of nicotine sulphate 40 per cent to 5 gallons of suds. Make the application immediately after combining the nicotine with the spreader. Since this combination is strictly a contact spray, only the insects hit are killed.

One can do much at harvest and in storage to reduce the thrip population for the next season. When the corms come out of the ground, cut the tops as soon as possible to prevent the thrips' migrating from the wilting foliage to the corms. Cure the corms in deep shade, preferably as far from the source of infestation as possible. Store the corms in a cool (50° to 40° F.) well-ventilated place over winter and treat any infested corms before planting.

Always plant corms free from thrips.

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WATERY APPEARANCE OF FROZEN HOMOGENIZED MILK

G. M. TROUT
SECTION OF DAIRY HUSBANDRY

The increased interest in, and sales of homogenized milk in Michigan and other sections of the United States have challenged the experiment stations for more information on many of the physical and chemical properties of the product. During the last 10 years much experimental evidence has been produced, showing that many of the properties of milk are changed, depending upon heat treatment and homogenization pressures employed, by dispersing the milk fat so no cream layer is formed through fat globule rising.

In northern regions, frozen or partially frozen milk on the doorstep is not uncommon during the severe winter months. Especially is this true where early morning or night delivery is practiced. Hood and White (1), submitting a questionnaire to some 40 milk plants of Canada, found that three plants had received customer complaints on the watery appearance of frozen homogenized milk. They explained, "It is obvious that, when milk of this character freezes, the top of the milk in the bottle presents quite a different picture from the frozen cream plug found in the regular pasteurized product. Just how serious a condition of this kind is and how it affects the sale of homogenized milk is not known. The only practical solution is to avoid if possible frozen milk, and if the problem warrants attention, ways and means could be worked out by distributors experiencing this difficulty."

In view of these customer complaints, of the increasing acceptance of homogenized milk in Michigan, and of the possibility of frozen milk in Michigan during the winter months, the investigation of this problem in connection with other freezing studies seemed desirable.

Fifteen gallons of mixed whole milk testing about 4 per cent fat was pasteurized at 143° F. for 30 minutes, and was then divided into five equal lots. These were homogenized at the temperature of pasteurization at 0, 500, 1500, 2500 and 3500 pounds pressure respectively. The milk was immediately cooled in ice water and, when cooled, was bottled or placed in 100 ml. cylinders for study. The milk was stored at 40° F. before subjecting to the freezing exposure of 0° F. The frozen milk was thawed either rapidly by placing the cylinders in 100° F. water or thawed slowly by exposing it to 70° F. air. After complete melting, the samples were returned to the 40° F. room where they remained for 24 hours. Various portions of the milk were syphoned off and analyzed. Sudan III and cheese color were both used effectively in the making of photographs.

Quart bottles of the milk were frozen also and examinations made at various freezing periods. Considerable data have been gathered in these studies and it is hoped they may be incorporated in a later, more

complete paper on the study of frozen homogenized milk. Some observations and practical aspects of the freezing of homogenized milk are included herein.

The Rate of Freezing of Bottled Homogenized Milk—Observations and measurements taken on many series of freezing milk show that the homogenized milk freezes slightly more quickly than the unhomogenized milk. This is undoubtedly due to the different insulation values of the milk ice resulting chiefly from creaming or lack of creaming of the milk. Analysis of the frozen and unfrozen portions of unhomogenized milk, of unhomogenized milk heated to prevent creaming within a normal period, and of homogenized milk showed the unfrozen portions to be richer in fat when there was little or no creaming and when the quart samples were frozen approximately 50 per cent. Frozen milk heated sufficiently high to inhibit creaming in a normal period of time yielded fat tests showing a similar trend to that observed in frozen homogenized milk. The difference in insulation values between the frozen portions of unhomogenized and homogenized milks was illustrated by freezing pure water under the same conditions as that of the milk (Fig. 1). Here it will be noted that a greater percentage of water remained unfrozen than did either of the milks. The nearer the frozen portion approached the composition of water apparently the greater was the insulation.

There was some indication that the milk homogenized at 2500 or 3500 pounds pressure, froze slightly faster than did that homogenized at 500 or 1500 pounds. However, this would seem to be of minor importance.

As one observed the rise of the bottle caps during freezing, he

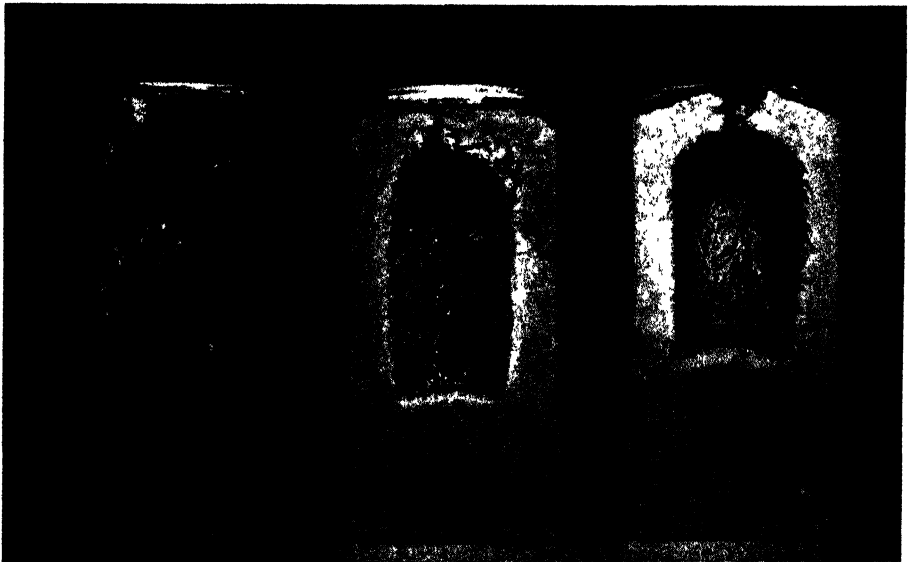


Fig. 1. Cross-sections of quart samples of water, unhomogenized milk and milk homogenized at 2500 pounds pressure after holding 6 hours at 0° F.

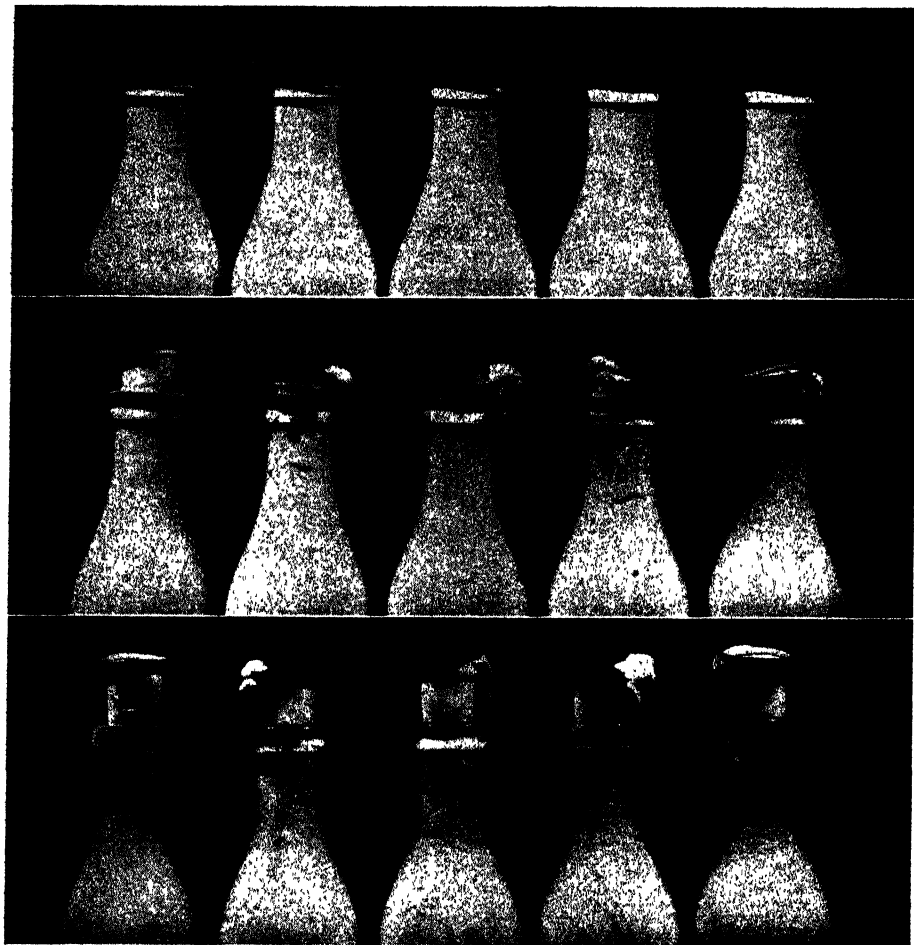


Fig. 2. Series of milk homogenized at 0, 500, 1500, 2500, and 3500 pounds pressure after 3 and 6 hours exposure at 0° F. The 6-hour frozen homogenized milk appeared to exhibit a cream layer similar to that of the unhomogenized milk.

would doubtless conclude that the unhomogenized milk froze more quickly than the homogenized milk. This conclusion might be reached naturally because the cap on the bottle of unhomogenized milk was always the first to be forced above the bottle and was generally from one-half to three-fourths of an inch higher than those on the bottles of homogenized milk at three hours of freezing. However, the difference in the levels of the caps on the bottles of homogenized milk from that on the unhomogenized milk gradually diminished and at six hours were practically at the same height above the bottle. The cap on the bottle of unhomogenized milk usually remained horizontal whereas those on the bottles of homogenized milk were generally at an angle (Fig. 2).

It should be pointed out, however, that the actual percentage differences in the rates of freezing of homogenized and unhomogenized milk were small despite the seemingly wide differences as judged from appearances. At three hours at 0° F., the average percentage of milk frozen, as shown by five trials of each series, were 58.3, 59.1, 60.2, 61.1

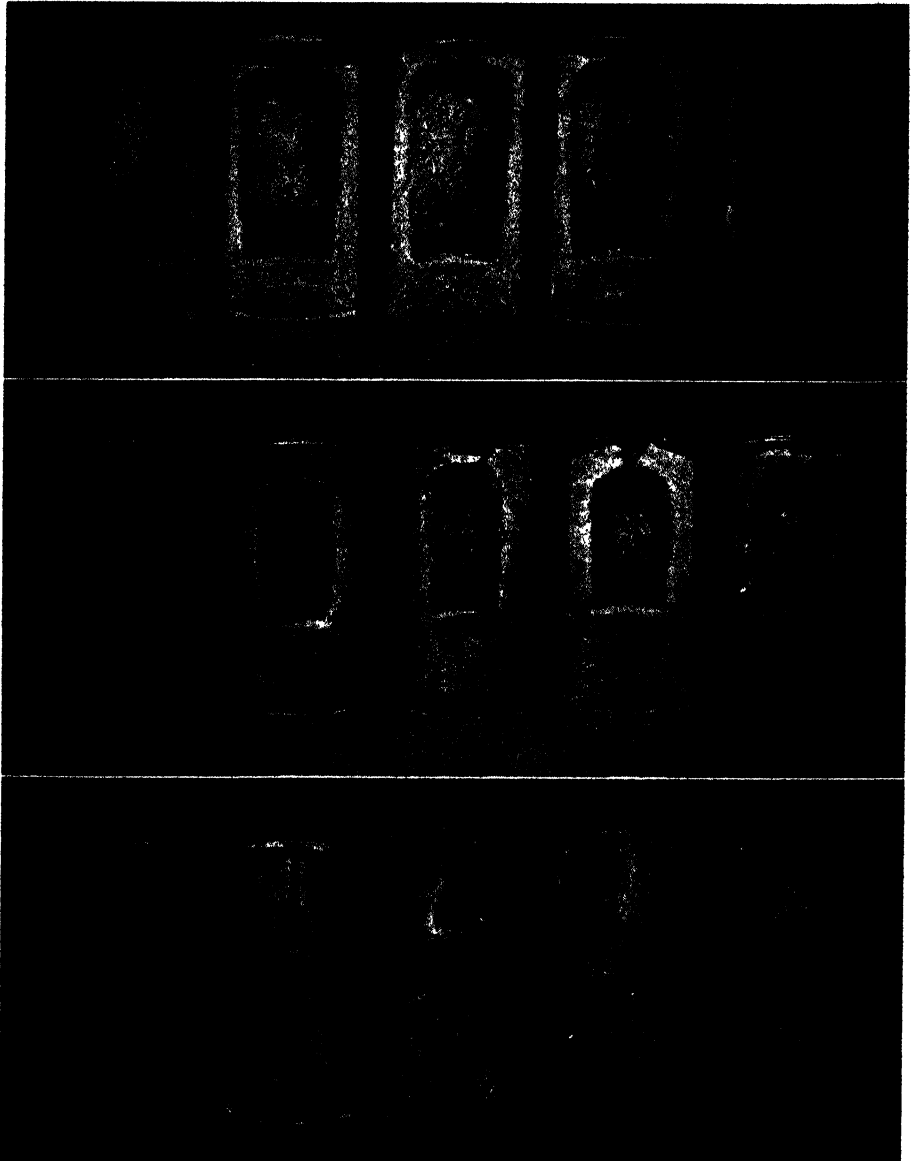


Fig. 3. Cross-sections of quart samples of milk homogenized at 0, 500, 1500, 2500, and 3500 pounds pressure after 3, 6, and 9 hours storage at 0° F.

and 60.9 for milk processed at 0, 500, 1500, 2500, and 3500 pounds pressure, respectively. Cross-sections of the various lots of milk after three, six, and nine hours exposure at 0° F., showing the manner in which quart Sealright containers of milk homogenized at various pressures freezes, may be seen in Fig. 3. Freezing seemed to progress more rapidly from the bottom than from the sides or top of the container.

Appearance of the Frozen Plug—The frozen plug on the unhomogenized milk was usually straight, parallel, and clean cut, whereas that of the homogenized milk was generally tilted, had uneven edges, and could usually be designated by a frozen “candle drip” which had exuded from under the cap (Fig. 2).

The texture and hardness of the plugs of the two milks were entirely different, owing chiefly to creaming. This difference in hardness and flexibility likely accounted for the different behaviors of the caps and the appearance that the unhomogenized milk was freezing more rapidly. The upper layer of unhomogenized milk, commonly referred to as the cream layer, yielded a softer, more pliable plug than did the homogenized. This plug could be readily forced out of the neck of the bottle as freezing progressed, whereas that of the homogenized milk, having less fat, was hard and icy and could be forced out only under great pressure. By placing a tube with alcohol in the center of the bottle and connected with a manometer, the internal pressures of the bottles during freezing of the milk were studied. The internal pressures of the bottles of homogenized milk at a given time were found to be greater than that in the unhomogenized milk. Thus the



Fig. 4. Vertical cross-sections of quart samples of unhomogenized and homogenized (3500 pounds pressure) milk after 24 hours at 0° F.



Fig. 5. Vertical cross-sections of quart samples of milk homogenized at 0, 500, 1500, 2500, and 3500 pounds pressure, respectively, after 24 hours at 0° F.

“candle drip” edge may be explained by the release of the greater internal pressure forcing some of the unfrozen milk through the center of the partially frozen plug rather than by forcing the entire plug upward. This exudate upon freezing formed the “candle drip”.

The Breaking of Bottles Through Freezing—Apparently the slightly more rapid freezing of the homogenized milk in association with a harder, less-pliable plug, thus finally creating a greater internal pressure, would ultimately cause the bottles containing homogenized milk to break somewhat sooner than those containing unhomogenized milk. Such was actually the case. Dozens of bottles were frozen to breaking and of the entire series the bottles containing the homogenized milk were the first to break, those containing milk homogenized at 500 pounds pressure breaking just prior to the bottles of unhomogenized milk (Fig. 2). Breaking occurred after about 6 to 7 hours exposure at 0° F., the bottle containing the unhomogenized milk breaking within 15-25 minutes of the bottles containing the homogenized milk.

Cross-sections of Frozen Milk—Horizontal and vertical cross-sections of unhomogenized and of homogenized milk are presented in Figs. 4, 5, and 6. A study of the vertical cross-sections seemed to show a shorter ice lattice structure, extending to the center, in the homogenized milk than in the unhomogenized milk. The center of the unhomogenized milk seemed to lack the short icicle structure of the homogenized milk, but appeared glassy. The unhomogenized milk exhibited a different surface freezing also because of the presence of the cream layer. Only slight differences were noted in the horizontal cross-section patterns of the frozen unhomogenized and homogenized milk when examined at the one-third and two-thirds levels from the top of the container (Fig. 6).

Color and Appearance—When in the frozen state, the plugs of both the unhomogenized and of the homogenized milks were remarkably similar in color. In fact, there was no suggestion of a watery appearance of the frozen homogenized milk—when in the completely frozen

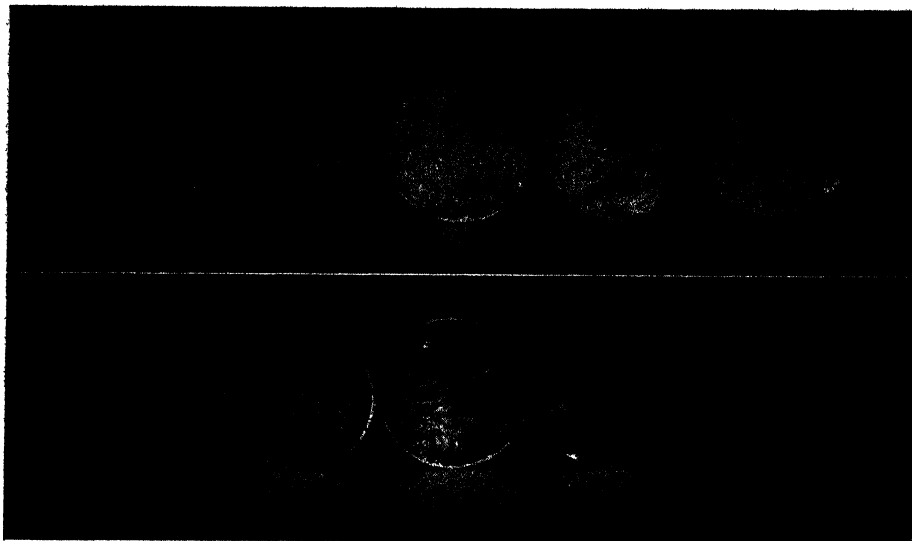


Fig. 6. Horizontal cross-sections, taken one-third of the distance from the top and from the bottom, of quart samples of milk homogenized at 0, 500, 1500, 2500, and 3500 pounds pressure, respectively, after 24 hours at 0° F.

state. The dispersion of the fat by homogenization gave to the entire bottle of homogenized milk a yellowish color which was somewhat lighter than that of the cream layer of the unhomogenized milk. However, upon freezing, the plugs of the two milks did not present a contrast in color, yet were remarkably similar, both being slightly translucent and lemon-yellow in color (Fig. 2). After the bottles of frozen milk had remained for some time at 40° or at 70° F. for thawing, the plugs of the homogenized milk lost their yellowish color and became snowy or watery, the plug on the unhomogenized milk exhibiting chunks or flakes of frozen cream on the surface and a somewhat heterogeneous appearance. Analysis of the drainage from the melting frozen milk showed the first portions to have more than 20 per cent total solids, and as melting continued, the "melt" contained less total solids, the latter portions being relatively poor in total solids; hence, the watery appearance of the partially melted plug.

Appearance of Thawed Frozen Homogenized Milk—Flakiness was not evident in frozen homogenized milk upon melting as was commonly observed in the frozen unhomogenized milk. The frozen homogenized milk that was thawed and then mixed appeared as smooth as the unfrozen milk.

Although the color of the frozen homogenized milk was yellowish and rich looking when the milk was in the frozen state, such milk did present at the top of the container a thin, weak, watery appearance when thawed, especially when thawed slowly by exposure to the air at room temperature (Figs. 7 and 8). When the milk was thawed rapidly by placing the container in lukewarm water, the milk was more normal in appearance. In general, the higher processing

pressures, 2500 and 3500 pounds, gave a larger volume and more watery appearance than the lower pressures of 500 and 1500 pounds. The cream layer on the frozen unhomogenized milk shrank slightly following melting and usually showed a shallow watery layer immediately underneath which was rather inconspicuous. Freezing and thawing seemed to aid creaming in the samples of milk heated sufficiently high to inhibit creaming. Such milk showed a slight cream layer after 48 hours with no watery appearance as on the frozen homogenized milk. However, the immediate under layer appeared bluish somewhat resembling the color of skim milk.

Analyses were made on various portions of milk having a watery appearance resulting from the freezing and thawing of homogenized milk. Apparently, from the data obtained, the fat globules of homogenized milk are either loaded down with the destabilized protein and consequently sink toward the bottom, or are filtered out by the settling of the destabilized protein, the lower layers being considerably richer both in fat and in solids-not-fat than the upper portions. No creaming was encountered when homogenized milk was frozen. Rather the reverse was true. Instead of creaming, the fat of slowly-thawed, frozen homogenized milk exhibited marked settling. These differences were noted also in rapidly-thawed, frozen homogenized milk but not to the same extent. Worthy of mention here also, in connection with the appearance of frozen homogenized milk as affected by the rate of thawing was the effect of the rate of freezing. Some cylinders that



Fig. 7. Cylinders of milk showing the presence or absence of the watery surface layers after freezing. Group A was processed at 0, 500, and 3500 pounds pressure, unfrozen; group B, similar milk frozen solid at 0° F. then thawed slowly in air at 70° F.; and group C, similar to group B, but thawed rapidly in a water bath at 100° F.



Fig. 8. Cylinders of milk homogenized at 3500 pounds pressure. The one at the left was unfrozen; the one in the center was frozen at 0° F. then thawed slowly at room temperature; whereas the one on the right was similarly frozen, but thawed rapidly in a water bath at 100° F.

were frozen partially and others that were frozen very slowly at a temperature slightly below freezing and then thawed slowly exhibited a watery appearance similar to that noted when the milk was exposed at 0° F. for several hours and then allowed to melt slowly. This

seemed to be in accordance with Sommer (2) who stated that there must be a zone in the freezing range where destabilization is at a maximum and that if a sample of milk is taken through this zone rapidly there should be less evidence of destabilization than in slow freezing. Apparently that which applies to slow freezing applies to slow thawing as well.

Importance—While the information gained in these studies may serve to explain the watery appearance of thawed frozen homogenized milk, the characteristics of the freezing of homogenized milk, and may contribute to the knowledge of this phase of dairy science, the information should be of especial interest to regulation and control officials who are called upon from time to time to check not only the fat content of the milk but the efficiency of homogenization as well. The milk ordinance and code recommended by the United States Public Health Service (3) defines homogenized milk as follows: "Homogenized milk is milk which has been treated in such manner as to insure break-up of the fat globules to such an extent that after 48 hours storage no visible cream separation occurs on the milk and the fat percentage of the top 100 cc. of milk in a quart bottle, or of proportionate volumes in containers of other sizes, does not differ by more than 5 per cent of itself from the fat percentage of the remaining milk as determined after thorough mixing." Information gained in these studies shows that creaming does not occur when homogenized milk is frozen, and hence no difficulty regarding an increase in fat percentage in the upper 100 ml. of milk need arise from that source. On the other hand, should homogenized milk be frozen slightly, as might occur under some conditions, fat analyses of the upper 100 ml. may not give a true picture of the legality of the milk.

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METHODS OF RETARDING THE RIPENING OF STRAWBERRIES IN NORTHERN MICHIGAN

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SECTION OF HORTICULTURE

The development of transportation and refrigeration and the rapid influx of tourists to Michigan during summer months have been the chief factors that have made strawberry growers realize the importance of late ripening. Usually northern states that produce berries commercially send their fruit to markets already flooded with the last of the crop from states farther south. These final pickings are usually slightly less attractive than the first few arriving from northern states and the result is a sharp decline in the price received for all of the fruit. As yet, northern Michigan has but little competition from other strawberry-producing areas after the last week in June. Fruit placed on larger markets during and after that time almost always sells at a premium. A study of Detroit and Chicago market quotations for the years 1928 to 1935 has revealed that an average increase of 75 cents to \$1 per 16-quart crate is very common from June 20 to July 4.

Object of the Study

The object of this study has been to find the best method or methods to retard the ripening of strawberries in northern Michigan without curtailing quality or quantity of the crop, and by so doing, to take advantage of the late season advance in prices on larger fresh fruit markets in north-central United States.

Procedure

Two measured one-half acre plots of the Dunlap variety were set with the rows 3 feet and 9 inches apart, and the plants 20 inches apart in the rows. These plots were situated at the same high elevation with good air drainage, and on the same type of heavy, fertile, sandy-loam soils. They were located approximately one-fourth mile apart, one on a gentle north slope, the other on a south slope of almost identical gradation. Both plots were previously planted to alfalfa which was followed by corn one year before the strawberry planting was made early in the spring of 1932. Identical cultural conditions were maintained in both plantings until September 1, at which time cultivation was discontinued. Eighteen-inch matted rows had developed by freezing weather. These rows were mulched with wheat straw on November 30 and December 1 to a depth of approximately 3 inches after the straw had settled. At this time the ground was frozen to a depth of 2 inches, and was covered with 3 inches of snow. Outlines of rows were still visible. It required $2\frac{1}{2}$ tons of material to cover the mulched portion of the acre of plants. Check rows were selected along each

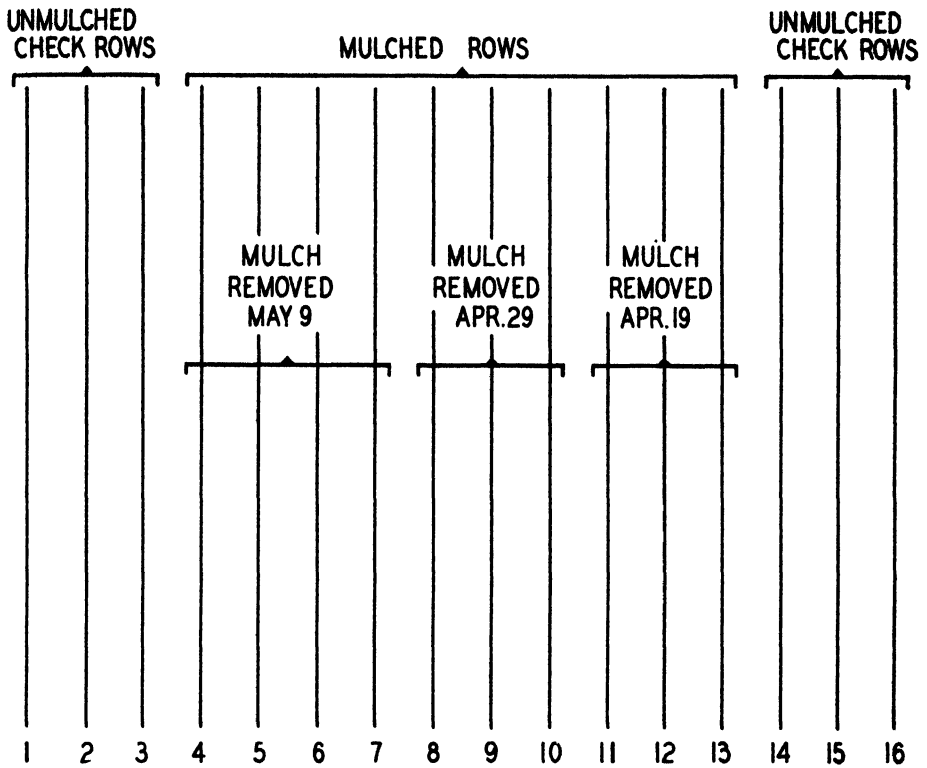


Fig. 1. Plan of the method of planting and mulching of the 1932 plantations on both north and south slopes.

Table 1. Treatments of plots on north slope, yield per row and average yield per row for each plot.

Row	Treatment of Plot	Picking Dates and Yield per Row in Quarts									Yield per Row	Average Yield per Row for Each Plot
		June 23	June 26	June 30	July 3	July 7	July 10	July 14	July 17	July 21		
1 2 3	Unmulched	7 6 4	27 24 4	20 17 9	8 6 9	2 7 8	0 3 2 5	0 0 0	0 0 0	0 0 0	64 0 63 0 37 5	54 83 qt.
4 5 6 7	Mulch Removed May 9		8 14 16 20	8 20 14 13	24 15 17 21	20 22 28 28	26 24 25 22	17 19 23 21	7 11 20 20	6 5 8 5	109 0 123 5 151 0 130 0	128 37 qt
8 9 10	Mulch Removed April 29		15 15 14	13 14 19	15 16 10	21 22 24	26 26 18	17 24 20	22 10 9	3 0 0	132 0 112 0 105 0	116 3 qt.
11 12 13	Mulch Removed April 19		13 15 23 5	18 30 16	22 12 16	23 5 32 18	28 23 10	21 11 0	14 9 0	0 0 0	147 5 132 0 94 5	124 0 qt.
14 15 16	Unmulched, but Plants dug along Rows loosened soil.	2 2 2	19 29 26	17 23 7	14 11 7	5 8 6	9 3 2	1 5 0 0	0 0 0	0 0 0	77 5 84 0 50.0	70 5 qt.
Total Yield 1,581.0 qt.												

side of the plots to avoid excessive snow coverage which would act as a mulch. The planting and mulching were done as illustrated in Fig. 1.

Additional data were required; so as early as possible in 1933 two plots 20 by 20 feet were measured alongside the bed on the north slope, and the heavy sand loam in one replaced by fertile clay loam to a depth of 18 inches. Also another one-half acre planting was made on the north slope next these two plots (Fig. 2).

The procedure of handling the soil in 1933 was the same as that in 1932, including the clay loam in the 20 by 20-foot plot. This transferred soil was allowed to settle well before planting.

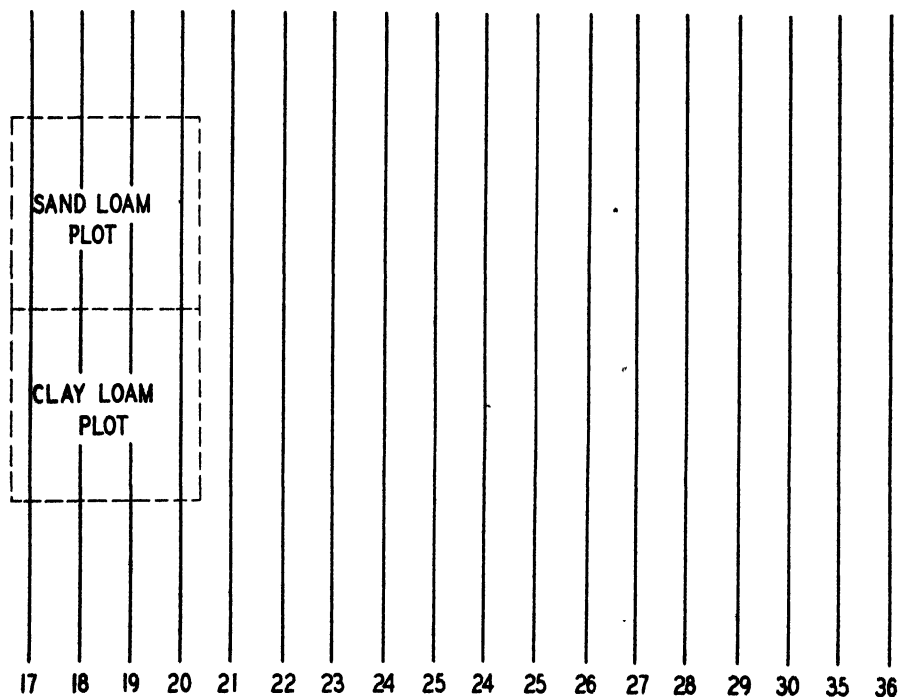


Fig. 2. Plan of the 1933 planting, sloping to the north.

Plants for the 1933 bed were removed from the sides of the 1932 check rows 14, 15 and 16. That this digging, which was a type of cultivation, had considerable effect on the yield of the latter rows is shown in the yield record (Table 1).

After the crop was harvested from the 1932 planting, the mulch was removed with a hay rake, piled at one end of the field, and the plants mowed. The patch was renewed by plowing, harrowing, and cultivating. Rows were narrowed to 10 or 12 inches in width. Three applications of ammonium sulphate were added to the rows marked with an "X" in Fig. 3 to determine whether increased vegetative growth probably occurring would retard ripening of the fruit. This fertilizer

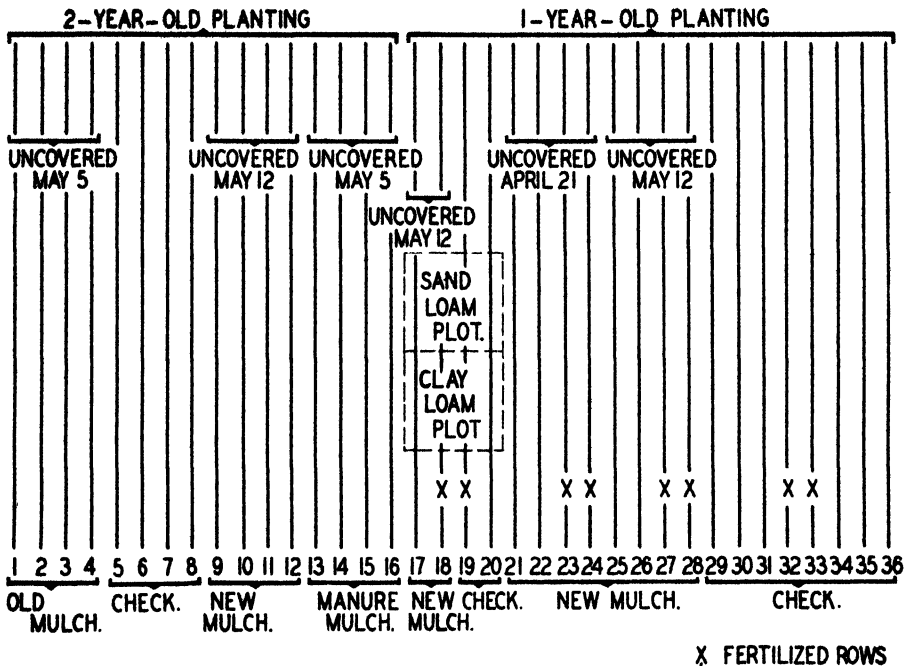


Fig. 3. Showing system of mulching and rows fertilized in both 1 and 2 year old plantings during 1933-1934 on north slope.

was applied during the spring and summer of the year the plants were growing and again in the spring of the fruiting year.

The seasons of 1932-33 and 1933-34 were averaged for this locality both as to rainfall and temperature, except night temperatures during the week of February 4-10, 1934, which ranged from -30° F to -40° F. A snow cover of approximately 18 inches protected all beds to the extent that no injury was apparent after growth started the following spring. No yield records were kept for the beds on the south slope because of the obviously greater difference in earliness of fruit produced on it as compared with the plots sloping north. The author was interested most in retarding berries still further on that slope.

Old straw mulch, new wheat straw, and coarse horse manure were compared in value as mulches.

Data for 1933

As soon as frost was out of the ground, April 19, three rows were uncovered and the mulch placed between them. The remaining rows which were mulched were uncovered April 29 and May 9, making an interval of 20 days between the times where the first and last mulches were removed. Growth under rows uncovered last was advanced considerably and the plants were becoming yellow at their tips.

Unmulched rows sloping south received their final picking June 23 at which time unmulched rows sloping north were just beginning to

come into production. Mulched rows on the south slope received their final picking on June 30. Table 1 is a complete record of the picking dates and yields of the plots sloping north for the year 1933. These results show an outstanding increase in yield and retardation of crops obtained by mulching. The fact that there were only three days' difference between the time fruit ripened on the mulched and unmulched rows, and that first fruits on all mulched rows ripened at the same time, make it apparent that development of bud clusters and fruits must have been much more rapid on unmulched rows uncovered last.

Data for 1934

In 1933-34 the plots were mulched and treated as illustrated in Fig. 3. Results of the dates of pickings of the two-year-old plantation are illustrated in Table 2 and picking dates of the one-year-old plots in Table 3.

Table 2. Dates of pickings of the two-year-old plantation.

Plot	First Picking	Largest Picking	Last Picking
Old straw mulch uncovered May 5	June 14	June 25	July 5
Check	June 14	June 22	July 2
New Straw mulched, uncovered May 12	June 18	June 29	July 13
Manure mulched, uncovered May 5	June 14	June 25	July 8

Table 3. Picking dates of one-year-old plots.

Plot	First Picking	Largest Picking	Last Picking
Sand loam mulched, uncovered April 21	June 14	June 27	July 14
Sand loam mulched and fertilized, uncovered April 21	June 14	June 27	July 14
Sand loam mulched, uncovered May 12	June 18	June 30	July 19
Sand loam mulched and fertilized, uncovered May 12	June 18	June 30	July 19
Sand loam check	June 14	June 20	July 9
Sand loam check, fertilized	June 14	June 20	July 9
Clay loam mulched, uncovered May 12	June 20	July 2	July 23
Clay loam mulched and fertilized, uncovered May 12	June 20	July 2	July 23
Clay loam check	June 18	June 25	July 15
Clay loam check, fertilized	June 18	June 25	July 11

Discussion

Results of these experimental trials indicate that there are outstanding differences in the period of ripening of strawberries to be obtained by growers who can take advantage of (a) soils of desirable texture and slope, and (b) the proper use of mulch and its method of application and removal. Direction of slope is one of the greatest factors entering into the early or late production of berries, a north slope resulting in a nine-day retardation of the first fruits on the Dunlap variety as compared with a south slope. An additional four-day delay was obtained by planting on clay loam soil rather than on sand loam; however, if the heavier soils are high in organic nitrogen it is

apparent that great care must be taken in the methods of fertilization practiced, especially during wet seasons.

The period at which mulch is removed from the plants seems to have but little effect on the date on which the first fruits ripen. The first fruits from plants uncovered both early and late ripen at the same time. Leaving the mulch on as late as possible without injuring plants, delays mid-season pickings from one to three days and retards the end of the picking season four to five days as compared with the harvest from plants uncovered early. The mulch which is removed last and is loosened after most spring rains are past will dry more rapidly than that mulch transferred early. However, this factor is more than offset by the evaporation it prevents from under the row during the time the row is still covered. The addition of fertilizer containing nitrogen does not influence the date of ripening but does increase the amount of fruit set and the yield when moisture is not a limiting factor.

It would seem, then, that if a grower is to produce late fruit he should select a fairly heavy soil if it is available, and then obtain the variety of strawberry best adapted to that soil. He should make his planting on a north slope if possible. This will retard ripening of the fruit and improve moisture-holding conditions of the soil. Mulch should be applied at that season of the year which will best afford protection for the plants and absorb moisture that will be needed to bring those plants into production. The grower can aid in the latter process by removing the mulch as late as possible in the spring, but before injury to the plants is caused. The time for removal is when growing tips begin to show a considerable amount of yellow underneath the mulch. It would be advantageous not to disturb the mulch any more than necessary in placing it between the rows, as this hastens evaporation of moisture from the straw and the soil underneath it. However, it may be necessary to fork the mulch back over the rows to prevent injury by freezing on cold nights. Moving it would undoubtedly hasten the drying of the mulch, but might protect the crop from total loss due to freezing.

Little is to be gained in mulching value by using manure or old mulch used the previous year. Both are so fine in texture that applications heavy enough to serve as a desirable mulch would smother the plants. Cultivation of plants not mulched, one or two times before they blossom in spring, will prove beneficial in supplying a soil mulch to prevent considerable loss of moisture.

The quantity of fertilizer that can be added profitably will depend mainly on three things: (a) the kind of soil, (b) its state of fertility, and (c) the quantity of moisture present during the fruiting season. Nitrogen present in the quantity that will result in large foliage growth previous to the fruiting season will result in a large demand for water by the plant at the period the fruit is ripening. Lack of water at this time will cause more injury than would occur on unfertilized plants. Also an excessive supply of nitrogen on heavy soil with high moisture content will cause the fruit to be soft and of poor shipping quality. However, the average northern Michigan soil that is adapted to strawberry growing can receive moderate applications of nitrogen during the time the plants are growing and differentiating fruit buds, and again while the fruit buds are developing, with very beneficial results

on total yield. This method of application will not retard the fruiting season.

Summary

1. A north slope retarded production of fruit of the Dunlap variety nine days as compared with a south slope.

2. Clay loam soil retarded production four days more than did sand loam soil on the same north slope.

3. Mulching with wheat straw in November, after freezing weather had begun, resulted in substantial increases in yield from all plots on both north and south slopes, regardless of the date the mulch was removed (up to May 12).

4. Horse manure and old straw mulch used the year previous are not satisfactory to use for mulching strawberries because they are so fine in texture that applications heavy enough to be of value in preventing moisture evaporation and retardation cannot be made, owing to possible injury to plants. However, light applications of either material resulted in larger yields than those obtained on check rows.

5. Mulch retarded the beginning of the picking season only three or four days, but it retarded the dates of largest pickings from seven to ten days, and the last pickings the same number of days.

6. The greatest value of mulch is apparently the winter and spring protection it affords plants from extreme cold and temperature changes, as well as the benefit accruing from its absorbing and retaining moisture, which allows plants to bring to maturity a larger number of the fruits that set.

7. Mulch which was removed early and placed between the rows allowed the rows to dry out sooner, but the mulch became more firmly packed and retained a larger quantity of moisture in the soil between the rows than did mulch removed later in the season.

8. Mulch not transferred until later in the spring allowed the rows to receive the benefit of moisture retained from melting snow and rain, owing to its packed and undisturbed condition before moving, but dried out sooner after it was removed and placed between the rows because of having been loosened and stirred when weather was dry and warm.

9. The addition of nitrogenous fertilizer increased the number of flower clusters, the number of fruits set, and the yield of all except the check plots, but it had no retarding effect of any kind on fruiting.

10. Addition of nitrogenous fertilizers to the check plots resulted in increased vegetative growth which required more moisture than did plants on unfertilized rows. Owing to a lack of mulch, soil under the fertilized rows became dry.

CHINESE ELM IN MICHIGAN

A. B. BOWMAN
SECTION OF FORESTRY

The first Chinese elms (*Ulmus pumila*) were introduced into Michigan in 1916 and 1917 when the Bureau of Plant Industry sent eight plants to the Forestry Department, Michigan Agricultural College, for distribution and observation. Some of these plants were set out along avenues, some on lawns as shade trees and others in the forest nursery of the college, the purpose being to study and report on their development, hardiness, and habits of growth in this new environment. The plants came originally from Fengtai Province, near Peking.

Mature Chinese elm trees may be distinguished by uniformly fissured, blackish bark on the main trunk turning to gray on the younger portions of the tree, buds which are dark brown and nearly round, and leaves that are much smaller than those of the native elms. In common with other elms the tree produces flat wafer-like seed in large quantities early in the spring. In its native habitat it reaches heights of from 50 to 75 feet and is from 2 to 3 feet in diameter. It usually presents a pleasing appearance unless misshapen by ice injury.

The Chinese elms that were distributed locally have grown at a remarkably fast rate. In 24 years the eight original trees have reached an average diameter of 16 inches, breast high, or an average growth of two-thirds inch per year. This is exceptionally rapid growth for a region having so short a growing season as Michigan. Two of the largest specimens, one 19 inches in diameter and the other about 18 inches, were cut recently, yielding 115 cubic feet of fuelwood, or about four stove cords. A 14-inch 16-foot sawlog, containing 135 board feet, could have been taken out of the larger one. These trees were open grown, but every indication points to fast growth even in more crowded forest conditions. From the standpoint of quantity production of cellulose very few species would exceed the Chinese elm.

Such rapid growth should immediately establish the importance of the Chinese elm wherever an area must be covered with tree growth or shade must be furnished quickly. That characteristic and the fact that the tree is outstandingly resistant to drouth, wind and extremes of heat and mid-winter cold, account for its popularity in various parts of the United States, particularly the prairie states and the semi-arid southwest. The Chinese elm is an upland tree primarily, although it will grow on a wide variety of site conditions but not in swamps. Furthermore, it is easy to propagate from stem or root cuttings or from seed and is relatively free from most insect pests and diseases.

As a windbreak tree it has proved very satisfactory also. It does not furnish year-around protection, as most conifers do, but it will offer effective protection against drying summer winds within a very few years after establishment. It also will withstand violent wind

whipping and heavy trimming; in fact, in its homeland, it is commonly used to form hedges.

In regions where other species can be grown readily, the use of Chinese elm as an avenue tree or even as a shade tree is questionable. First, it is regarded by practically everyone who owns one as a "dirty" tree. This is because (1) it sheds an over-abundance of seed, sometimes enough to smother the grass, (2) it drops leaves weeks later than other trees thus prolonging the raking problem, and (3) it sheds numerous small dead twigs throughout the year. Second, the wood, being very brittle, frequently is unable to withstand the weight of ice left by

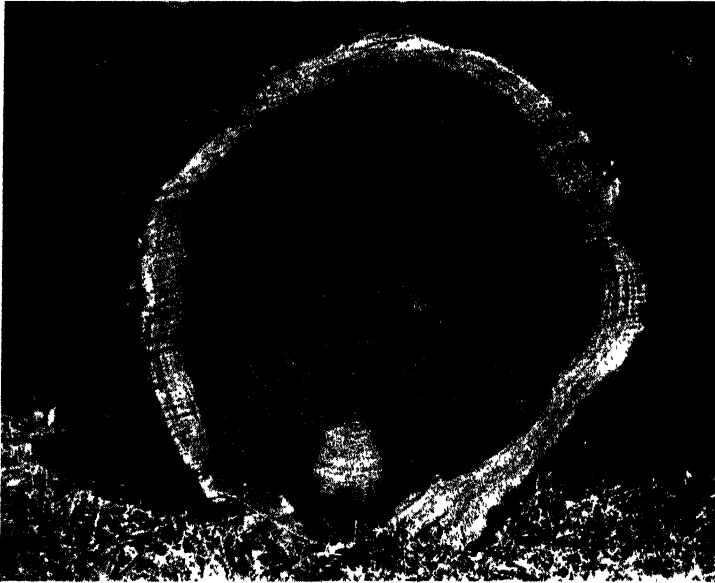


Fig. 1. Section from Chinese elm measuring
24 inches in diameter in 24 years.

sleet storms and in regions where these storms are common the trees are often badly damaged and misshapen. Third, the tree, in search of water and nutrients, not only sends its roots to great depths, but also into the sod layer in unusual numbers. This deprives the sod of much needed moisture; at least the grass does not thrive. Also, when set out within reach of any sewage tile, it will invariably force its way into the tile at the joints and clog the passage with a tangle of roots. For these habits it is known as a "gross feeder" and probably owes a portion of its fast growth to those traits. On the other hand, where it is difficult to get trees to grow, objectionable features such as those can easily be ignored.

CROP SEQUENCE EFFECTS AND THE RESULTS WITH THE SUGAR BEET CROP ON THE MERRILL FARM OF THE LAKE SHORE SUGAR COMPANY, MERRILL, MICH.

J. G. LILL*
SECTION OF FARM CROPS

Since 1932, the Lake Shore Sugar Company, the Michigan State College Agricultural Experiment Station, and the Divisions of Soil Fertility Investigations and Sugar Plant Investigations of the Bureau of Plant Industry, have co-operated in experimental studies at the Merrill, Mich., farm of the Lake Shore Sugar Company to determine the effects of various fertilizers and of the preceding crop on sugar beet yield and quality.

The special tract of the farm set aside for this work was divided into three sections. Each season, one section of the area was occupied by special crops in preparation for the experimental crop of sugar beets to be grown the following season. The preparatory crops used in this experimental work were corn, oats, barley and pea beans. These crops were grown each season in 16 crop blocks, four for each crop, randomized in the section in Latin square arrangement. The soil preparation for these four preparatory crops was uniform throughout, and no fertilizer was applied. Following harvest of the preparatory crops, all crop blocks in the section received the same soil preparation, all blocks being plowed and fitted at the same time for the sugar beet planting. Beginning in 1933 and in each season thereafter, sugar beets were planted over the area which had been occupied by preparatory crops the preceding season. After the experiment started, the unused section in any year was uniformly cropped to barley. During the seasons of 1932 to 1936, sweet clover was seeded with the barley. From 1937 to 1939 inclusive, the barley on the unused sections was grown alone.

In the experimental work conducted, the crop sequence studies were combined with tests of commercial fertilizers. The fertilizers were applied to the experimental crop of sugar beets in such a manner that each of the 16 different crop blocks of the preceding season received the same amount and the same kinds of commercial fertilizer, applied in the same manner. Thus, among the various crop blocks the effects of the fertilizer applications were balanced. By taking the average results for the sugar beets on each of the different crop blocks, the fertilizer effects were eliminated and the differences in the results obtained may be assigned to the influence of the preceding crops.

The sugar beets were planted, blocked, thinned, and cultivated in the customary manner for a crop of beets. The crop was harvested

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according to the special sub-plots which were set up. At harvest, the sugar beets, after being lifted, pulled, and topped as for the factory, were carefully cleaned, weighed, and samples taken for quality determinations. By combining the data of appropriate sub-plots, the results may be studied with reference to the crops that had been grown on the replicated crop blocks of the preceding season.

Only six years' results are available from this experimental work since the experimental crop of sugar beets was "drowned out" in 1935. During three of these seasons, weeds were a very pronounced factor and seemed to have definite association with the preceding crop. During the other three years, the weed factor was practically non-existent, irrespective of the preceding crop. The data obtained have been evaluated on a basis of 4 x 4 Latin square for each season. The results obtained in the three weed-free seasons have been summarized separately as Section A of Table 1 and are included in the general summary for all seasons in Section B of Table 1.

Table 1. Effects of the preceding crop upon the yield and quality of the sugar beet crop: Experiments on the Merrill farm, Merrill, Mich., in 1933, 1934, 1936, 1937, 1938, and 1939. (Results are given as 3- and 6-year averages; data for each year are from 4-plot averages for each sequence type, calculated to acre basis.)

Section A—Average for 1933, 1936, and 1938, weed factor negligible.

Previous Crop	Number of Marketable Roots	Acre Yield of Roots	Sucrose Percentage	Apparent Purity Coefficient	Calculated Sugar Production ¹	
					Gross	Indicated-available
		(tons)			(pounds)	(pounds)
Oats.....	16,480	10.348	15.02	85.58	3,101	2,653
Barley.....	16,816	10.985	14.93	85.34	3,266	2,789
Beans.....	17,204	11.471	14.54	85.04	3,329	2,838
Corn.....	17,362	11.215	15.09	85.97	3,410	2,934
Difference required for significance.....	1448	10.503	10.13	10.52	.....	1140

Section B—Six-year averages.

Oats.....	13,325	8.679	15.43	85.85	2,665	2,292
Barley.....	13,400	8.934	15.34	85.66	2,726	2,340
Beans.....	14,982	10.122	15.12	85.49	3,036	2,604
Corn.....	15,550	10.295	15.51	86.19	3,187	2,753
Difference required for significance.....	1967	10.762	10.15	10.36	.....	1219

¹Highly significant differences of the magnitude shown could not occur by chance more than once in 100 trials.

²Significant differences of magnitude shown could not occur by chance more than once in 20 trials.

³The data in these columns will not cross check since the values shown for gross or indicated-available sugar are averages of the individual plot determinations.

The soil of the area where this experimental work was located is a Brookston loam, or a very closely allied soil type, and is representative of a considerable area of central Michigan soils used for sugar beets. The productivity level is relatively high and the yields obtained from crops commonly grown in this part of Michigan are

usually very satisfactory. As shown in Table 1, the results with the sugar beet crop obtained with this productive soil were affected to a noticeable extent by kind of crop which was grown immediately preceding.

The preceding crop was found to influence the number of marketable roots obtained, the average individual root weight produced, and, accordingly, the total yield of roots produced. Again, the preceding crop influenced to some extent the quality of the sugar beets produced, and with both yields and quality of the roots produced being affected, it is logical to conclude that sugar production was also associated with the type of cropping that preceded. In these tests, the largest number of marketable roots per unit of area, as an average, was obtained when sugar beets followed the corn crop. Sugar beets planted to follow the bean crop ranked second in number of marketable roots, whereas sugar beets following the non-cultivated crops, oats and barley, gave the lowest number of marketable roots. In both the three-year and six-year comparisons, more marketable roots were obtained when sugar beets followed barley than when the crop followed oats.

Acre-yields were found to follow closely the trends shown by numbers of marketable roots. Thus, the highest yielding sequences commonly showed highest stands. The comparison between sugar beet crops following corn and those following beans deserves attention. In weed-free years, there was considerable difference in average individual root weights in two sequences in favor of the beans-sugar beet sequence as compared with the corn-sugar beet sequence. The average for these three years shows a greater acre-yield of roots from the first-named sequence. The six-year average, however, is in favor of the corn-sugar beet sequence, the advantage being attributable to the greater number of marketable roots. Sugar beets grown following the non-cultivated crops gave lower numbers of marketable roots and lower yields, as an average. The sugar beet crop grown following barley was superior in number of roots and in acre-yield to the crop grown following oats. This relationship was true not only for the three weed-free years but for the six-year average.

The sucrose percentage and the apparent purity coefficient determine the quality of the roots produced. From determination of the sucrose percentage, the total amount of sugar contained in a ton of roots can be calculated; the apparent purity coefficient gives some indication of the proportion of this total amount that may be available. According to the data presented in Table 1, the quality of the roots obtained when sugar beets follow the corn crop was slightly better in all cases than the quality of the roots when any of the other crops preceded sugar beets. The sugar beets produced in the bean-sugar beet sequence were slightly lower in quality than those produced when sugar beets followed any of the other crops. The sugar beet roots produced on plots in which non-cultivated crops were grown the previous year were not so good as those produced when corn preceded, but were slightly better than the sugar beets which were produced following beans. The quality of the roots in the oats-sugar beet sequence was slightly superior to that in the barley-sugar beet sequence.

These differences in quality, attributable to the preceding crop, are believed to be definite but, in general, are too slight to influence the production of sugar to any considerable extent. It is found, therefore,

Table 2. Average annual and 6-year advantage with crop sequences at Merrill farm, Merrill, Mich.: Acre-yields obtained in oats-sugar beet sequence taken as base.

Previous Crop	Advantage in acre-yield of roots		Advantage in acre-yield of indicated-available sugar	
	Yearly	6-Year	Yearly	6-Year
	(tons)	(tons)	(pounds)	(pounds)
Oats.....	0.0	0 0	0	0
Barley.....	+0 255	+1 530	+ 48	+ 288
Beans.....	+1 443	+8 658	+312	+1,872
Corn.....	+1 616	+9 696	+461	+2,766

that the acre-yields of indicated-available sugar follow very closely the root yield. In this respect, the amount obtained when sugar beets followed cultivated crops was definitely higher than the amount obtained when sugar beets followed non-cultivated crops. Comparing the two cultivated crops, corn and beans, in their effects on the succeeding sugar beet crops, the average acre-yield of indicated-available sugar was greater if sugar beets followed corn. Comparing the non-cultivated crops, sugar beets grown following barley, the average acre-yield of indicated-available sugar was higher than when sugar beets followed oats. This was because of higher root yield, although the quality of the beets was slightly lower.

Although the nature of the preceding crop has been shown to affect the sugar beet crop in a number of different ways, the most important effect is upon the root yield and consequently upon the indicated-available sugar produced. Taking the results obtained following the oat crop as a basis, the yearly and total advantages accruing to the sugar beet crop from the various other crop sequences are set forth in Table 2. The yearly advantages in the better sequences are comparatively small; if considered as an aggregate for the years of the test, a practical measure of the gains obtainable by giving attention to proper crop sequence is shown.

The experimental work indicated definitely that crop sequence effects on the sugar beet crop should be taken into consideration when planning a crop rotation including sugar beets. Certain crop sequences can be chosen which entail no important increase in cost of producing the sugar beet crop or may even decrease costs. Such advantages, therefore, represent greater efficiency in crop production.

THE STONE YARD FOR SMALL TURKEY FLOCKS

ASHLEY BERRIDGE
LAKE CITY EXPERIMENT STATION

Because of poor sanitary conditions, the production of turkeys in small farm flocks, often reared with other poultry, is definitely on the decrease. On the other hand, the number of large flocks of turkeys is increasing. The large flocks are usually yarded, away from other poultry, and managed under approved methods of sanitation.

The producers of the small flocks evidently give little thought to the prevention of disease. From these flocks come many of the low quality birds, which often depress the market. Improved methods of rearing and better sanitation practices would reduce mortality and improve market quality.

Experimental work in the feeding and housing of turkeys has been carried on at the Lake City Experiment Station since 1933. From 400 to 500 turkeys are grown each year. Of these, 300 are reared in an open-front turkey house, 25 x 100 feet, containing 10 pens with capacity of 30 turkeys each. In this work the turkeys must be of different ages and breeds. Necessarily more turkeys are hatched in each lot than needed. Since 1936, stone yards have been used for the rearing of these extra turkeys. These yards provide all of the advantages of close confinement and yet are so simple in construction that they can be recommended for use on any farm where there is a mortality problem in connection with turkey raising.

There are several reasons for the close confinement of small turkey flocks:

First—The turkey flock is definitely located. It is not good management to have turkeys roaming over the farm. Semi-confinement in small fields usually is inconvenient and often difficult. It is much better to have the turkeys each year in the same place, convenient to the building and to the feed and water supply;

Second—Sanitation is improved. Small yards and buildings can be kept clean. Visitors, animals, and other carriers of disease can be kept out. Mixing with other poultry can be prevented. Disease prevention is the basis of successful turkey raising;

Third—Market quality is improved. The opportunity for close observation by the attendant can improve feeding methods. The daily contact with the birds in small quarters, the absence of excitement, and generous feeding tend to produce rapid growth and better finish. Selections for local trade of properly finished turkeys can more easily be made.

Building the Stone Yard

The building of the stone yard is not difficult in most sections of Michigan. The size of the yard depends upon the number of turkeys

to be confined; 125 turkeys can be raised to maturity in a yard 70 x 80 feet in size. Medium-sized to small field stones can be used. Cobblestones from the highway gravel screen are satisfactory. Fine gravel or sand should not be used. The location of the yard is important. Many trips have to be made in caring for the turkeys. It should be near the house, easily available to water, feeds, lights and protected from high winds. The soil is also important; preferably it should be sand or of a porous nature. Good drainage is necessary and, when built on clay, the yard should slope. The layer of stones must be deeper on water-holding soils. The secret of a successful stone yard is that each rain will carry away droppings and cleanse the stones. There must never be standing puddles of water in the yard.

The fence should be durable and high enough to keep the turkeys in and intruders out. A fence of woven wire, 6 feet high, with either steel or strong wood posts is satisfactory. It is advisable to clip the feathers on one wing of each hen. Heavy toms do not attempt to fly out.

Roosts

The roost should be constructed to provide protection from the sun and storm as well as being a comfortable place for the night. An inexpensive roof of wood, steel, asphalt roofings, canvas or even brush may be used over perches of cedar poles. Since the stones of the yard get hot on a bright summer day the roost is often used by the turkeys during mid-day hours. Protection from the cold, wet storms of autumn can be provided by wood or burlap being tacked on two sides of the roosting quarters. The type of shelter used in the original stone yard



Fig. 1. A satisfactory stone yard for turkeys is equipped with a covered roost, covered feed hoppers and a wire mesh false-floor for drinking utensils.

at Lake City is a simple bleacher-shaped roost, 10 feet square, and with the top perch 6 feet from the ground (Fig. 1). The cedar poles are 11 feet long and 4 inches in diameter. A sloping steel roof is 8 feet from the ground in front and 7 at the rear. Such a roost costs little to build and will last for many years. It must be screened with 2-inch poultry netting, under the perches, and around the lower part so that the turkeys can never get under the roosts.

Management

Feed hoppers should be provided with out-door covers so that the feeds will be dry at all times. These should be moved frequently from one part of the yard to another. Drinking utensils, preferably crocks, should be placed on wire mesh false-floors several feet square (Fig. 1). Green feed such as lawn clippings or chopped green alfalfa should be available at all times in practical feeders. A yard or two of fine gravel can be dumped in one corner for dusting and to provide grit. This should be raked clean frequently.

The turkeys reared on the stone yards at the Lake City Station have been free from disease and they mature into high quality meat birds. They are placed in the yards from the brooder house at eight to ten weeks of age and remain there until ready for market. In the four years at Lake City, the turkeys have not developed sore feet from contact with the cobblestones. The yards have now been used four years and rains and sunshine have kept them clean and sanitary. At the beginning of each season the roosts and feeders are disinfected thoroughly and painted. All droppings are removed from under the perches. Very little needs to be done to the yards except to stir the parts of the yard with a rake where the droppings do not completely wash away. A thorough job of disinfecting and cleaning each spring is the best insurance that there will be no difficulties during the remainder of the season.

Use of the stone yard for close confinement is a method of rearing turkeys that can be safely adopted. It is of especial value to the farmer who has other poultry, to the farmer with a small acreage of land and to the near-city dweller with high priced surroundings.

BULLETIN REVIEWS

Tech. Bul. 171—A Study of Three Methods of Research in Home Management.—Gross, I. H., Aiken, A., Tordt, T., Zwemer, E. A., and Baten, W. D.—Study of home management practices, initiated in the fall of 1936, had as a general objective the study of present practices in all phases of management of material and human resources in the home with a view to setting up norms, possibly standards of management in the home. The investigators decided that before an analysis of home management practices was begun it would be wise to study the methods of research which might be used in this field. The findings of the study which made a comparison of three methods used to evaluate home management are offered in this bulletin.

Forty-one farm women made reports concerning home management practices as carried on in their own homes by keeping a diary for one week, by filling out a questionnaire, and by granting an interview. A group of four typical cases in which the three methods were answered in the same order was used as the basis for detailed study of each phase of home management. It was found that the interview with 81.1 per cent of the relevant questions answered was far superior quantitatively to the diary where only 20.6 per cent of questions was answered, and considerably better than the questionnaire with 67.7 per cent answered. Each method included questions on money management, use of goods and services, use of time and energy, and long-time plans. For the study of the entire 41 sets of responses, 21 key questions were evolved to cover the four phases of home management. The answers given to the key questions by each person were classified so that the methods might be compared in quantity of information received, in the definiteness or clarity of the answers, and in vividness. When the differences between the means of the total number of answers to each of the three methods investigated were tested for significance, the interview and questionnaire were found to surpass the diary in quantity of information and clarity of response. The diary, however, surpassed the questionnaire and interview in average number of highly vivid answers and also in number of answers below average in vividness. The conclusion may be drawn that the interview was the most successful method for obtaining information concerning home management practices from a selected group of rural women and that the questionnaire ranked second. The diary fell greatly below the other two methods except in the vividness of its answers. A score giving the desirability of one method compared with the other two combined yielded a weight of 27 for the interview, 16 for the questionnaire, and 9 for the diary. (19 pp., 12 tables.)

Tech. Bul. 172—An Electrical Resistance Method for the Continuous Measurement of Soil Moisture Under Field Conditions.—Bouyoucos, G. J., and Mick, A. H.—An electrical resistance method of measuring soil moisture *in situ* under field conditions is described. Porous blocks

are imbedded in the soil. The moisture content of the absorbent material varies with that of the soil. The soil's electrical resistance varies inversely as its moisture content. Hence block resistance is an index of soil moisture.

Absorption blocks are satisfactorily made of plaster of paris. This material has proved to have many desirable characteristics, such as expansion upon setting (which provides a satisfactory electrode interface), a wide moisture range, and the property of rapidly absorbing and losing water. Laboratory and field studies have shown these blocks are mechanically strong and may possibly survive several years' use since they are neither crumbled by root growth, broken by freezing, nor dissolved.

A portable A. C. bridge operating at high frequency has been devised to measure the resistance of the blocks.

This apparatus will measure the "available" moisture in soil. Its sensitive range includes all of the soil moisture between the wilting coefficient and the field capacity. Changes in the salt content of ordinary soils do not appear to interfere with these measurements.

Moisture trends may be followed by burying an absorption block and merely noting the resistance readings. Constant low resistance indicates that the moisture level is at or above the field capacity. As the soil loses its available moisture, the resistance of the block increases. The wilting point corresponds to about 60,000-75,000 ohms.

Accurate moisture determinations may be obtained by calibrating the apparatus for every soil. The approximate experimental error varied from 0.1 to 1 per cent in the experiments performed. Field studies have proved this method to be convenient and rapid since, after the blocks have once been installed, only a few seconds are necessary to determine the block resistance. (38 pp., 11 tables, 13 figs.)

JOURNAL ARTICLE ABSTRACTS

Relation of Cracking of Graft Coatings to the Stand and Growth of Apple Scions.—Cardinell, H. A.—Amer. Soc. Hort. Sci. Proc. **37**: 291-293. 1939 (1940). [Journal Article No. 319 (n. s.) from the Michigan Agricultural Experiment Station.]—Apple cleft-grafts on which eight melted wax formulae, seven water emulsified asphalts, and two non-drying plastic materials were tested gave the following results: (1) The plastic materials resulted in poor stand and poor growth of scions, (2) The average of the asphalt coatings was as good as that of the brush waxes, (3) There was no relationship between waxes that cracked little or not at all and those that cracked severely or fell off entirely, on the stand of scions at the end of one season's growth. It appears that other factors may be more responsible for stand and growth of scions than whether or how severely the union coating cracks.

Bi-serial r for Horticultural Research.—Crist, J. W.—Proc. Amer. Soc. Hort. Sci. **37**: 269-271. 1939 (1940). [Journal Article No. 339 (n. s.) from the Michigan Agricultural Experiment Station.]—The occurrence of measurements not expressible in cardinal numbers is somewhat frequent in horticultural research. This necessitates groupings merely in the form of alternate categories with quantitatively indefinable and undefined limits. Nevertheless, the degree of correlation with the variables concerned is desirable. The biometrical technique of the so-called bi-serial r is available for the purpose, and the article, cited above, demonstrates its use with reference to the relationship between the color of apple fruits and their content of total sugar, the data being not actual but assumed. The relation between this measure of correlation and that of the ordinary coefficient of correlation, together with the magnitudes of their errors in the same set of measurements, is briefly discussed.

Entomological Usage of Subspecific Names.—Sabrosky, C. W.—Entomological News. **51** (6): 159-164. 1940. [Journal Article No. 354 (n. s.) from the Michigan Agricultural Experiment Station.] A survey of 21 representative North American entomological journals, covering approximately 750 volumes of the 50-year period 1890 through 1939, was made to determine the actual usage by North American authors of all intra-specific categories such as variety, subspecies, race, etc. The high frequency of the term variety (55.4%) led to the conclusion that such extensive use of names other than "subspecies" should be an important practical consideration in the discussion of their status in zoological nomenclature.

Nuclei in Actinomyces.—Newcomer, E. H., and KenKnight, G.—Mich. Acad. Sci. **25**: 85-87: 1939 (1940). [Journal Article No. 357 (n. s.) from the Michigan Agricultural Experiment Station.] The genus *Actinomyces* comprises a group of organisms intermediate in many respects between fungi and bacteria and are variously classified as fungi,

bacteria, or a distinct group of organisms by the different investigators. The presence of a discrete nucleus is frequently regarded as an important criterion of phylogenetic significance for the separation of fungi from bacteria. By growing these organisms *in situ* on microscopic slides and using the Feulgen technic, the authors have described true nuclei in these organisms for the first time.

The Effect of Spacing on Plant Development and Yield of Dill (*Anethum graveolens* L.).—Seaton, H. L., and Baten, W. D.—Proc. Amer. Soc. Hort. Sci. **37**: 785-789. 1939 (1940). [Journal Article No. 374 (n. s.) from Michigan Agricultural Experiment Station.] The results from an experiment in 1938 on the effects of spacing on plant development and yield of dill (*Anethum graveolens* L.) are reported. Four different spacings between the plants grown in three-foot rows were used, namely: 4, 8, 12, and 16 inches. Each spacing was replicated four times in a randomized plot layout and the data were subjected to analysis of variance.

On the basis of individual plant development, plants spaced 16 inches apart were significantly larger in all respects than those spaced 12, 8, or 4 inches apart. The 16-inch spacing produced more branches, more compound umbels, taller plants, larger primary umbels, larger stems, greater green and air-dry weight of entire plant, greater weight of air-dry stems and seeds, a higher percentage of seeds and heavier seeds, than the closer intervals. No significant differences were exhibited by any of the four spacings on the number of primary rays in the primary umbels. This is partially explained by the fact that the effects of crowding were not operative during the early differentiation of the primary inflorescences.

However, when the data are put on the basis of 0.01 acre plots, the closer spacing of 4 inches, in every respect considered in these studies, would be significantly more profitable for the grower who is producing the crop at a specified price per ton. A 4-inch spacing produced more than twice as many branches as the 16-inch spacing and nearly twice as many branches as the 8-inch spacing. This spacing produced about twice as many umbels as the 16-inch interval. The number of primary rays in the primary inflorescences, on an .01 acre basis, were nearly four times that produced at the 16-inch spacing. As the primary umbel constitutes the most important portion of the crop this is a highly significant consideration for the grower. Similar significant differences are exhibited between the 4, 8, 12, and 16 inch spacings in the total heights of the plants, the total diameter of the primary umbels, total stem diameters, green and air-dry weight of the entire plants and air-dry weights of stems and seed where the closer spacing was by far the superior interval. The data presented indicate that even a closer spacing of the plants than 4 inches may be highly desirable for maximum acre yields. They further suggest that the rows may be spaced closer together than the 3-foot spacing given in this experiment.

The analyses of air-dry seeds for moisture and ether extractable materials show no significant differences between the seeds from the plants grown at the different spacings.

Studies on the Composition of Bovine Blood. II. Seasonal Variations in the Level of Magnesium in the Blood Plasma of Growing Dairy

Calves.—Duncan, C. W., Lightfoot, C. C., and Huffman, C. F.—*Journal Dairy Sci.* **23** (2): 125-134. 1940. [Journal Article No. 377 (n. s.) from the Michigan Agricultural Experiment Station.] The results of this study, based on the repeated determination of plasma magnesium in 2,286 samples of blood from 107 calves, show the changes in concentration of magnesium for the various calendar months and the marked seasonal drop that occurred during the transition from winter to summer conditions when the calves had to adjust themselves rapidly to new weather conditions.

A number of environmental factors, such as temperature, sunshine, precipitation, barometric pressure and relative humidity, have been considered and linear correlations have been calculated to show some apparent relationships with plasma magnesium but none have been found wholly satisfactory in explaining why these alterations occur in the animal body. Lower plasma magnesium values were associated with those months during which there were more than eight hours of sunshine per day and when the mean and maximum temperatures were above 55° and 70° F., respectively. The changes in concentration cannot be ascribed to the effect of solar radiation because the magnesium values obtained from the young calves which did not have access to direct sunlight responded in the same manner as those which were turned out to pasture.

The results of the study suggest a striking parallelism in the concentration of magnesium to changes in season. Periods of high and periods of low concentration not attributable to age or to the ingestion of food are definitely indicated.

The Influence of the Nitrogen Content of the Diet on the Calorie Balances of Pre-school Children.—Hawks, J. E., Voorhees, J. M., Bray, M. M., and Dye, M.—*Jour. Nutrition.* **19** (1): 77-89. 1940. [Journal Article No. 381 (n. s.) from the Michigan Agricultural Experiment Station.] Two long-time balance experiments were conducted with pre-school children in which the amount of protein was varied from 3 to 4 grams per kilogram of body weight. Period-to-period variations for excretory values remained constant on both diets while the absorption, and retention figures varied with the intake values. Changing from the 3- to the 4-gram protein diet reduced the actual number, as well as the percentage, of the intake calories available for body needs, but at the same time it produced greater weight gains in the children.

The Influence of Technic on the Composition Values of Identical Diets.—Hawks, J. E., Bray, M. M., Voorhees, J. M., Veley, B., Carlson, C., and Dye, M.—*Jour. Am. Diet. Assoc.* **16** (5): 416-419. 1940. [Journal Article No. 382 (n. s.) from the Michigan Agricultural Experiment Station.] Earlier studies at the Michigan Station showed that the composition values of many diets containing identical foods might vary considerably from the average figure of all analyses. Even the values for analyses of duplicate diets weighed from the same food at the same time varied somewhat. From a study of methods of reducing such differences it was concluded that (1) by purchase of staple foods in large enough quantities to last throughout an experiment, (2) by careful grinding and mixing of samples, (3) by use of torsion balances for quick weighing, the variations could be reduced to a limited extent, only the major portion of the variations apparently being due to other factors.

Influence of Feeds on Lecithin Content of Milk and Possible Relationship of Lecithin Content to Susceptibility of Milk to Copper-Induced Oxidized Flavor.—Gould, I. A., Fox, W. K., and Trout, G. M.—Food Research. **5** (2): 131-139. 1940. [Journal Article No. 383 (n. s.) from the Michigan Agricultural Experiment Station.] Milk obtained from cows on high-fat and low-fat ration, on corn and alfalfa, or on a balanced ration with or without pasture supplement did not vary appreciably in lecithin content. Eighty samples of milk secured from cows on a high-fat ration averaged 0.0474 ± 0.0009 per cent of lecithin in the milk and 0.9892 ± 0.0311 per cent of lecithin on the fat basis. An equal number of samples from cows on a low-fat ration averaged 0.0461 ± 0.0011 per cent of lecithin in the milk and 1.0184 ± 0.037 per cent of lecithin in the fat. The average lecithin content of 198 samples of milk was 0.0460 ± 0.0006 per cent, and 0.9930 ± 0.0209 per cent, when calculated on the basis of the fat in the milk. A high negative correlation existed between the percentage of fat in the milk and percentage of lecithin in the fat. However, no relationship was detected between the susceptibility of milk to copper-induced oxidized flavor and the lecithin content.

Roughage Quality and Quantity in the Dairy Ration, a Review.—Huffman, C. F.—Jour. Dairy Sci. **21**: 883-980. 1939. [Journal Article No. 384 (n. s.) from the Michigan Agricultural Experiment Station.] The nutritive value of roughages for dairy cattle depends upon the amount of dry matter consumed, the chemical composition and the coefficient of digestibility of the dry matter.

Dry matter consumption is affected by factors inherent in the animal and those inherent in the ration and environment. There is a wide variation in dry matter consumption of cows on the same roughage. The palatability of roughages is not a reliable criterion to use in estimating the amount which cows will consume. The trend toward the use of properly managed pasture and hays and silage made from grasses and legumes cut at an earlier stage of maturity has resulted in an increase in roughage consumption per 100 pounds of body weight. Most cows will consume about three pounds of hay equivalent per 100 pounds of body weight, which is a 50 per cent increase in roughage consumption over the old "thumb" rule for roughage feeding.

Chemical composition has been shown to vary with the stage of maturity, soil conditions and climate. Young plants are characterized by their high protein content, low cellulose and lignin content and a high digestibility of their dry matter. The decreased digestibility of the dry matter with increasing maturity is believed to be associated in some way with lignification, although the total amount of lignin does not appear to be the determining factor. The greater use of properly managed pasture before the coefficient of digestibility drops makes the use of this class of roughage profitable. The data indicate that highly digestible roughage exerts a productive energy value about equal to that of concentrates on the dry basis.

The use of non-lignified grasses and legumes for winter feeding is very limited. This is due to low yields and the difficulty encountered in the field curing of such roughages. Fertilization to increase the yield of roughage and its conservation in the silo after wilting make possible the use of highly nutritious roughage throughout the year.

The nutritive value of hays cut at the usual stage of maturity depends upon the nutrients conserved during the curing process. Loss of nutrients during the field curing of hay is high during good hay making weather and very large during adverse curing weather. Better methods of conserving roughages are needed because poor hay-making weather prevails in many dairy sections. The cost of artificial dehydration of hays appears somewhat high at the present time.

Recent experiments indicate that grasses and legumes may be conserved economically in the silo with a loss of only about 10 per cent of the dry matter. In several experiments, however, the loss of dry matter in roughage conserved as silage was high. Most investigations indicate that the addition of from one to three per cent of molasses is advisable in the making of grass and legume silage. Inorganic acids may also be used to preserve these crops in the silo but molasses has the additional advantage of preserving the crop and contributing to the nutrition of the animal. Of the inorganic acids, phosphoric acid appears to have a slight advantage in silage making. It is easy to apply and it may contribute to the phosphorus requirement of the animal and to the fertility of the soil. Several investigators have reported that grasses and legumes make excellent silage without any treatment, provided the ensiled material has a moisture content of about 70 per cent and the trapped air is expelled by fine cutting.

Many of the silage investigations, however, have been conducted either in small containers or in very large silos. In both instances the results may not represent conditions in the average farm silo of about 50- to 100-ton capacity. In large silos the increased pressure may affect the moisture and carotene content of the silage as well as influence the capacity of the silo. There is very little difference in the dry matter capacity of the average silo for corn, grass or legume silage when the moisture and fineness of cut are about the same, but in large silos more dry matter can be stored as grass or legume silage.

Roughage protein appears to be well-balanced from the standpoint of the essential amino acids necessary for growth and milk production. The possibility of protein synthesis in the rumen by the rumen flora has been indicated.

Although grasses and legumes are probably very low in true fat, the results obtained with alfalfa alone suggest that when a liberal roughage program is followed there is little likelihood of encountering a fat deficiency. The possibility of a fat deficiency or of some factors closely associated with fat should, however, be considered.

The conservation of soluble carbohydrates in roughage is of practical importance because unfavorable weather conditions result in their loss in hay making. They may be of importance in maintaining the health of cattle during the barn feeding period. Ketosis has been shown to occur in cows fed rations low in soluble carbohydrates. This is explained on the basis of the new theory of rumen digestion which postulates the conversion of foods which stagnate in the rumen to fatty acids by bacteria. The soluble carbohydrates have a greater chance of escaping bacterial action.

Grasses and legumes are excellent sources of carotene when used as pasture, but when used as hay a large amount of the carotene is lost in field curing and during storage. The amount present in field-cured hay is sufficient to meet the physiological needs of cattle for

growth and reproduction when roughage is fed liberally. The conservation of carotene in roughages is of importance in the production of milk high in vitamin A. Several investigators have reported the preservation of large amounts of carotene in grass and legume silage by the use of either molasses or inorganic acids. The results obtained by the United States Department of Agriculture, Bureau of Dairy Industry, indicate that a preservative is not always needed for the preservation of carotene in grass and legume silages.

When green material is placed in the silo the resultant silage is low in vitamin D inasmuch as this vitamin is formed in the cured plant material during solar radiation. The feeding of four or five pounds of sun-cured roughage per cow daily will meet physiological needs of the animal for this vitamin during the winter months. Grasses appear to be good sources of vitamin E but whether or not cattle require this factor has not been ascertained. There is no evidence to indicate that the other vitamins in roughage are required in the ration of cattle.

Roughages are usually good sources of calcium and cattle have been shown to utilize about 50 per cent of the calcium in the ration when the supply of this element is rather low. There appears to be very little likelihood of a calcium deficiency occurring among cattle when they are allowed plenty of roughage.

Phosphorus is the mineral element which is most likely to be deficient in the ration of cattle when they are fed a roughage ration, because the phosphorus content of most roughage is low. The phosphorus content of roughage, under certain conditions, may be increased by phosphate fertilization but numerous instances have been recorded to show that the ordinary application of phosphate fertilizers to the soil did not influence the phosphorus content of the plant. Soil type and the moisture conditions are frequently the determining factors which influence the phosphorus content of the plant. In sections where the roughage is low in this element the addition of a phosphorus supplement to the ration of milking cows is indicated.

Roughages grown on soils containing iodine are good sources of this element but on those farms where "big neck" or goitre occur among newborn calves an iodine supplement should be supplied.

All of the other mineral elements required by cattle have been shown to be adequately supplied by roughage, with the possible exception of a few localities where iron, copper or cobalt are needed as supplements.

The high production of dairy cows on roughage alone, as reported by several investigators, is of great practical importance and also of scientific interest. In these studies cows fed alfalfa alone appeared to make exceedingly good use of the total digestible nutrients for maintenance and milk production. Kellner, Armsby and Fraps have discounted the digestible nutrients in roughage according to its crude fiber content in arriving at "starch values," "net energy values," and "productive energy values." Apparently the low productive energy value of the digestible nutrients in the roughage studied by many workers has been due to some factor other than the crude fiber content. Alfalfa hay as the sole ration in several experiments, however, did not give results comparable to its total digestible nutrient content. In view of the variations in the productive energy values of alfalfa hay which has been reported in the literature, a grain supplement should

probably be fed to cows in medium and high milk production. Rules have been suggested for feeding grain with roughage of good quality.

Vitamin B₁ Content of Eight Varieties of Beans Grown in Two Localities in Michigan.—Kelly, E., Dietrich, K. S., and Porter, T.—Food Research **5** (3): 253-262. 1940. [Journal Article No. 386 (n. s.) from the Michigan Agricultural Experiment Station.] The vitamin B₁ content of eight types of Michigan-grown beans (*Phaseolus vulgaris*) was determined by the rat-growth method; 642 animals were used. Estimations of the vitamin B₁ content of the different varieties of beans were made both from a curve of response of control animals to crystalline thiamin, and to the International Absorption Product. The values ranged from 1-3 I. U. per gram of dry, raw bean. The vitamin estimations were not identical for a given type of bean from both curves, but were of the same order of magnitude and gave the same comparative ratings for the different varieties.

The Relationship Between Leaf Area and Yield of the Field Bean with a Statistical Study of Methods for Determining Leaf Area.—Davis, J. F.—Jour. Amer. Soc. Agron. **32** (5): 323-329. 1940. [Journal Article No. 390 (n. s.) from Michigan Agricultural Experiment Station.] Data obtained from length and width measurements of field bean leaflets show that the total leaf area obtained by multiplying the length and width of the center leaflets by a factor obtained from planimeter measurements will give a reliable estimate of the leaf area of the bean plant. Leaf area can be taken by this method without removing the leaves since the only measurements necessary are the length and width of the center leaflet.

Planimeter measurements of 36 leaves are sufficient to arrive at a suitable factor.

Plants from plats receiving fertilizer had a greater average leaf area than plants from untreated plats but this difference was not significant. Similarly, the yields of plants from plats receiving fertilizer were greater than those from untreated plats but again significant differences were not found. These data point out that the inherent variability between individual plants necessitates using a number of plants sufficiently large to overcome this variability before a definite conclusion can be reached.

The Changing School Population and Its Implications.—Thaden, J. F.—Mich. Acad. Sci. **25**: 629-640. 1940. [Journal Article No. 391 (n. s.) from the Michigan Agricultural Experiment Station.] A rapid change in the character of the school population is taking place—a decrease in the elementary grades and an increase in the grades of the secondary school. In Michigan, enrollment in the elementary divisions dropped from 838,790 in 1930 to 691,544 in 1938, a decrease of 17.6 per cent. This is primarily the result of a falling off in the number of births, and to a lesser extent restricted immigration. The school is one of the first institutions to be affected by a declining number of births and by a slowing down of population growth and consequently it is among the first to face adjustments. Despite the rapidly growing proportion of youth of high school and college age attending school, enrollment in the high school can be expected to decrease in about four or five years and that in college within ten years.

Among the readjustments that declining school population is likely to encourage are: a five-year high school and a five-year college; more adult education and a growing proportion of teachers hired to devote part of their time to classes for adults and out-of-school youth; extending the span of compulsory school attendance, especially a lowering of minimum age restriction so as to make kindergarten and nursery school possible for more children; revision of the curricula of teacher training institutions by preparing instructors of adults as well as youth; and increasing competition between superintendents of graded schools for pupils in the outlying rural districts.

Palatability and Color of Potatoes Bought on a Retail Market.—

Griswold, R. M.—Food Research. **5**: 281-290. (1940). [Journal Article No. 392 (n. s.) from the Michigan Agricultural Experiment Station.] One hundred and fifty samples of "old" potatoes from three states were boiled, baked, scored by judges, and tested objectively for color. Mealiness shows highly significant positive correlations with other desirable palatability factors. The correlations between boiled and baked potato scores are positive and highly significant both for mealiness and judges' rating of general quality. Palatability increased with price and declined with storage from February to May. The color data correlate significantly with judges' scores for palatability, showing that a comparatively white potato will probably be scored higher by a group of judges than a darker potato.

Ascorbic Acid and Oxidized Flavor in Milk. II. The Effect of Various Heat Treatments of Milk upon the Stability of Ascorbic Acid and Upon the Development of the Oxidized Flavor.—Gjessing, Erland C., and Trout, G. M.—Jour. Dairy Sci. **23** (5): 373-384. 1940. [Journal Article No. 397 (n. s.) from the Michigan Agricultural Experiment Station.] Ascorbic acid was found to be relatively unstable in milk processed at 63° C. for 30 minutes when 0.13 mg. of copper per liter was added following pasteurization. Such milk was very prone to the development of the oxidized flavor upon three days storage. The ascorbic acid of some cow's milk seemed to exhibit a natural stability lacking in other samples. The rapid disappearance of the reduced ascorbic acid was not always an assurance that oxidized flavor would develop, for some samples lost their ascorbic acid on three days' storage without developing an oxidized flavor. The ascorbic acid exhibited a marked stability with no development of oxidized flavor when the milk was heated to 75° C. and held 30 minutes.

Flash pasteurization at temperatures ranging from 60-97° C. for 15 seconds had varying effects upon the stability of ascorbic acid. The critical flash exposure minima for ascorbic acid stability was between 75 and 85° C.

When mixed milk with and without copper was heated to 65, 70, 75, 80, 85, or 90° C. for 10 minutes the exposure at 80° C. had the greatest effect on stabilizing ascorbic acid and preventing oxidized flavor. When milk was exposed at 65° or 70° C. for 10 minutes the addition of copper **after** heating caused a more intense oxidized flavor than when copper was added **before** heating.

The Carotene Content of Several Herbagees During the Growing Season.—Snyder, W. W., and Moore, L. A.—Jour. Dairy Sci. **23** (5):

363-371. 1940. [Journal Article No. 398 (n. s.) from the Michigan Agricultural Experiment Station.] Variations in the carotene content of seven herbage including alfalfa, brome grass, corn leaves, the oat plant, the soybean plant, Sudan grass, and sweet clover, were studied during their growing season. Their carotene content is much greater during the earlier stages of growth than after they reach the stage of maturity at which they are usually harvested. Carotene content, when calculated in terms of micrograms per gram of dry matter, shows a rather progressive decrease as the plants mature except where affected by factors governing the rate of growth. In making hay or silage, in order to obtain the greatest carotene content the plants should be cut at an early stage of maturity.

Metallic Salts and Alkaloids in Agriculture.—Hutson, R.—Third Annual Symposium, Northwestern University. pp. 89-96. 1939. [Journal Article No. 399 (n. s.) from the Michigan Agricultural Experiment Station.] A resume of the extent to which metallic salts and alkaloids are used in agriculture, citing statistics as to the growth in the use of arsenicals on all kinds of crops in the last 20 years. Statistics on annual consumption of insecticides and the probable effect upon the market for arsenicals of the introduction of plant insecticides such as pyrethrum, nicotine, derris, and cube are cited. A list of 36 metallic salts and alkaloids, other than those used in large quantities, is included to indicate the constantly growing uses of poisonous materials for insect control. There is also included an evaluation of crop rotation, cultural methods, resistant varieties, and growth stage on the sale of insecticides.

Influence of Homogenization Temperatures Upon Lipolysis in Raw Milk.—Gould, I. A.—Ind. and Eng. Chem. **32**: 876-877. 1940. [Journal Article No. 400 (n. s.) from the Michigan Agricultural Experiment Station.] Raw milk was heated to 70°, 105°, 115°, 125°, 135°, and 145° F. and immediately homogenized at 1500 pounds pressure. A portion of each lot of milk was then pasteurized at 145-150° F. for 30 minutes, whereas a second portion was stored at 35-40° F. for 72 hours before pasteurizing. The purified fat secured from the milk was titrated for free fatty acids. The results showed maximum fat splitting to occur at the 105° F. temperature, with the samples processed at 115° and 125° F. showing only slightly less lipolysis. Considerable lipolysis occurred in the milk processed at 135° F., whereas a slight amount was observed in the 70° F. and 145° F. samples. The results for the 0-hour and 72-hour periods showed similar trends.

Further Observations on the Pollination of the Highbush Blueberry.—Merrill, T. A., and Johnston, S.—Proc. Amer. Soc. Hort. Sci. **37**: 617-619. 1939 (1940). [Journal Article No. 401 (n. s.) from the Michigan Agricultural Experiment Station.] Four varieties of highbush blueberries—Stanley, Jersey, Concord, and June—were self-pollinated by hand. Three different methods of pollination were employed. Results indicate each variety to be self-fruitful under Michigan conditions. Berries obtained from selfing were normal in size and ripening season.

Land-ownership Patterns in Relation to Land Types in Dickinson County, Michigan.—Schneider, I. F.—Papers of the Mich. Acad. of

Sci. **25**: 437-442. 1939 (1940). [Journal Article No. 403 (n. s.) from the Michigan Agricultural Experiment Station.] A survey of Dickinson County, Michigan, revealed that a marked change in the types of land ownership had taken place between the years 1916 and 1937. The acreages held by public agencies, cities, and villages, and agricultural ownership groups had increased at the expense of non-agricultural holdings. A decrease in acreage took place in the non-agricultural ownership and occurred mostly in the holdings of 5,000 acres or more owned by timber, mining, and speculative companies. Much of the acreage which reverted to state ownership was classified as poor soil, but it was noted that timber and mining companies ceased paying taxes in the better soil areas when their original intent in ownership had been fulfilled. It was further noted that the non-agricultural lands of the county were rapidly passing from private to public ownership. It is expected that some of this acreage will be converted to agricultural use in the future; but, if the present trend continues, it is reasonable to assume that more than 75 per cent of Dickinson County will have passed into state ownership and administration within the next 20 years. Acreages and the percentages of Dickinson County in each type of land ownership in 1916 and 1937 are given. Another table shows the acreage of the county classified by types of land ownership and by the percentage of change between 1916 and 1937.

Studies on the Bovine Electrocardiogram. I. Electrocardiographic Changes in Calves on Low Potassium Rations.—Sykes, J. F. and Alfredson, B. V.—Proc. Soc. Exp. Biol. and Med. **43**: 575-579. 1940. [Journal Article No. 406 (n. s.) from the Michigan Agricultural Experiment Station.] In a cooperative study in which the Departments of Physiology and Dairy Husbandry and Experimental Station Chemistry cooperated, it was found that calves maintained on rations containing 0.10 to 0.12% potassium developed marked abnormalities in their electrocardiograms. The outstanding change was a pronounced increase in the duration of the QRS interval to approximately twice that of the controls or of normal cattle. The changes in interval were accompanied by equally pronounced alterations in the contour and voltage of QRS. These abnormalities persisted even after the blood potassium level was raised to normal by increasing the potassium of the ration.

Stallion Semen Studies at Michigan State College.—Davis, K. and Cole, C. L.—Proc. Am. Soc. An. Prod. **32**: 81-85. 1939. [Journal Article No. 408 (n. s.) from the Michigan Agricultural Experiment Station.] Chemical and physical studies have been made of stallion semen working towards the long term preservation of spermatozoa for artificial insemination. Semen samples have been collected by means of a dummy horse. Principal observation of the semen from repeated collections using one stallion has been the extreme variation in quality and quantity of the ejaculate. The quantity of sperm may vary from a few hundred spermatozoa to several billion during the period of several weeks. Frequency of collection was not the deciding factor as to

quantity of ejaculate. Variation in quality was indicated by the fact that some constituents of the semen were entirely absent at some times and at others made up a large part of the collection. The effect of temperature is particularly noted in the pH determinations on stored and fresh samples of semen. All indications point to a metabolism in sperm cells differing from the usual type described in muscle cells.

Development of Molds on Cold Storage Eggs. I. Isolation and Identification of Molds Found on Cold Storage Eggs and Their Containers.—

Mallmann, W. L., and Michael, C. E.—U. S. Egg and Poultry Magazine **46**: 34-35. 1940. [Journal Article No. 409 (n.s.) from the Michigan Agricultural Experiment Station.] Molds were isolated from moldy eggs, moldy fillers and flats, and moldy cases obtained from cold storage houses. Eight hundred and fifty isolations were made, most of which were *Penicillia*. The same organisms were found on the fillers and flats as were found on the cases. The only organisms found within the egg were *Penicillia*, with the single exception of a species of *Hormodendren*. No one species of *Penicillia* could be incriminated as a causative agent.

The Effect of Several Spray Materials on the Size, Color and Percent Solids, of the Fruit of the Montmorency Cherry.—

Rasmussen, E. J.—Am. Soc. Hort. Sci. Proc. **37**: 367-370. 1939 (1940). [Journal Article No. 411 (n.s.) from the Michigan Agricultural Experiment Station.] Spray materials were found to influence the size, color and amount of solids in the Montmorency cherry. Trees sprayed with concentrations of bordeaux 4-6-100 and stronger produced cherries darker in color, smaller in size and higher in total solids than trees sprayed with lime-sulphur. Trees sprayed with weak concentrations of bordeaux and with proprietary copper materials produced cherries somewhat darker in color, higher in total solids and similar in size to fruit grown on trees sprayed with lime-sulphur.

Twig Growth in Mutants of Montmorency Cherry.—

Crist, J. W.—Proc. Amer. Soc. Hort. Sci. **37**: 245-249. 1939. (1940). [Journal Article No. 413 (n.s.) from the Michigan Agricultural Experiment Station.] This article consists in a biometrical analysis of the basic type and rate of vegetative growth in barren Montmorency mutants as compared with this phenomenon in normal, fruit-bearing limbs and trees of the same variety. The result is such as to indicate fundamental sameness in the law and type of this growth, but an hereditary difference with respect to rates. The specific rate constant for the mutant form appears to be lower. This, coupled with a relative deficiency in rate of carbon assimilation (formerly demonstrated), permits a physiological explanation, in part at least, of their failure to form fruit buds and their perpetual barrenness.

The Effect of Certain Fungicides on the Photosynthetic Activity of Sour Cherry Leaves.—

Murphy, L. M.—Proc. Amer. Soc. Hort. Sci. **37**: 375-378. 1939 (1940). [Journal Article No. 415 (n.s.) from the Michigan Agricultural Experiment Station.] Several recently intro-

duced, proprietary copper compounds for the control of cherry leaf spot have met with general success in several of the northern states. However, the value of these compounds depends not only on disease control but also on their physiological effects on the sprayed trees. A study was made to determine their effect on the photosynthetic behavior of sprayed cherry trees, employing dry weight increment method for measuring the photosynthate produced. The data indicate that from the standpoint of influence on photosynthetic efficiency, Cupro K is superior to Coposil, 6-8-100 bordeaux, and lime-sulphur as a spray for sour cherries.

Thinning the Apple Crop by Spray at Blooming: a Preliminary Report.—Gardner, V. R., Merrill, T. A., and Petering, H. G.—*Am. Soc. Hort. Sci. Proc.* **37**: 147-149. 1939 (1940). [Journal Article No. 416 (n. s.) from the Michigan Agricultural Experiment Station.] Tests were made in the spring of 1939 with different concentrations of a large number of spray materials to determine their effectiveness as blossom-killing agents when applied at the full-bloom stage. The most effective killing agent tried was di-nitro-cyclo-hexyl-phenol (Dow Dormant). At concentrations as low as 0.1 per cent some flowers of Duchess apples were killed with no apparent injury to foliage. At concentrations of 1 per cent nearly all flowers were killed, with considerable accompanying foliage injury. At concentrations of 0.25-0.50 per cent, large percentages of the flowers were killed, accompanied by some but not serious foliage injury. Addition of some wetting agent such as Santomers or Aerosol so as to provide a concentration of 0.1 per cent increased considerably the effectiveness of the spray. Similarly the addition of Dowax to provide concentrations of 1 to 8 up to 1 to 24 increased the effectiveness of the spray.

Development of Molds on Cold Storage Eggs. II. Prevention of Growth.—Mallmann, W. L., and Michael, C. E.—*U. S. Egg and Poultry Magazine* **46**: 98-101. 1940. [Journal Article No. 418 (n. s.) from the Michigan Agricultural Experiment Station.] Sodium penta-chlorophenate in concentration of 0.4 per cent, when impregnated into fillers and flats, prevented the growth of molds not only on the fillers and flats but also on the eggs stored in treated fillers and flats. Molds were prevented from growing in relative humidities of 95-98 per cent at a temperature of 34° F.

Studies on the Bovine Electrocardiogram. II. Bundle Branch Block.—Alfredson, B. V., and Sykes, J. F.—*Proc. Soc. Exp. Biol. and Med.* **43**: 580-584. 1940. [Journal Article No. 423 (n. s.) from the Michigan Agricultural Experiment Station.] In this study the electrocardiographic effects produced by cutting the branches of the His-bundle in calves and in dogs were determined. Section of the bundle branches in calves produced only minor changes in duration of QRS while similar procedures carried out on dogs resulted in a definite increase in the QRS interval. The form of QRS after section of the right bundle branch in calves was scarcely distinguishable from the

control curves. The QRS curves obtained after section of the left bundle were variable but were distinctly different from the controls. Bundle branch block of either left or right branch in dogs produced curves markedly different from those of the controls. It was apparent that section of the branches of the His-bundle in calves did not produce the marked changes noted when similar procedures were carried out on dogs.

It was concluded that the distribution of the Purkinje system is not similar in the calf and the dog heart and that this dissimilarity accounts for the fact that bundle branch block produces less pronounced changes in calves than in dogs.

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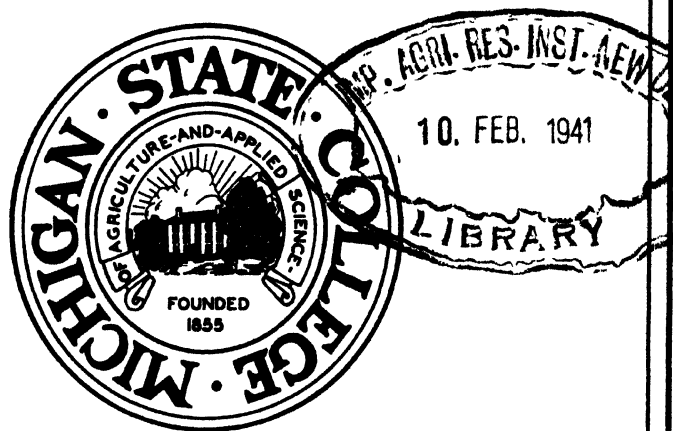
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**EDITED BY
V. R. GARDNER AND A. A. APPLIGATE**

**CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION**

NECROTIC ENTERITIS

AN OLD DISORDER—A MODERN NAME—A NEW PREVENTIVE TREATMENT

A disorder of swine that during recent years has come to be known as necrotic enteritis is by no means a new disease. Descriptions of swine diseases found in farm journals and books and articles on the ailments of livestock that were written nearly a century ago leave little doubt that many of the animals of that day exhibited symptoms now recognized as characteristics of necrotic enteritis. Sometimes it was referred to as "swine plague" or "bloody scours" or some other semi-descriptive term. Sometimes it was confused with hog cholera and doubtless that disease has been blamed for many losses which have been due to enteritis or to still other causes. The presumption is that it has existed for centuries, perhaps for as long as there has been a swine industry. How much loss it formerly caused, however, there is no way of estimating, partly because of this confusing with other disorders and partly because records of losses are very fragmentary. Even today many farmers and some veterinarians do not recognize at least the milder cases of the disease and consequently do not attribute to it the losses for which it is responsible. Those in close touch with the swine industry, however, and who are able to fairly accurately diagnose swine disorders, say that it probably ranks first in importance as a cause of death losses in the herds of the state and that it is indirectly responsible for much additional financial loss in the way of lowered resistance to other diseases, slower gains in weight and less efficient utilization of feeds. Sometimes it causes death losses of 50 per cent in individual herds in the course of a year; losses of 20 per cent are common.

Though several organisms have been found to be associated with the disease, more recent studies have led to the belief that a single one, *Salmonella choleraesuis* is the primary causal agent. Certain other organisms and certain conditions have been recognized as possible contributing factors, but control measures, both remedial and preventive, have been based largely on the theory that the disease is caused by a specific bacterium and have been limited largely to an effort to eliminate or to reduce the number of these organisms and thus prevent or reduce infection. Recognition of the identity of the disease, attributing it to a single, or at least a principal, causal agent distinct from that causing hog cholera, designating it by the more modern names of paratyphoid or necrotic enteritis, and employment of disinfectants and sanitary methods as control measures briefly represent the progress that has been made with the disease during the last two or three decades.

In the meantime, as a fund of information has been accumulating about necrotic enteritis in swine, much has been learned regarding many diseases affecting other domestic animals and about the diseases

of human beings. Some diseases, e. g. tuberculosis, have been found to affect many kinds of livestock or perhaps both human beings and certain kinds of livestock. Sometimes the symptoms of a specific disease exhibited by one class of livestock are very similar to those shown by another; sometimes they are quite different. More and more, however, research workers in the fields of both human and animal physiology, pathology, and medicine are coming to look to discoveries in the other fields for light that they may throw on their own problems. So it is but natural for an investigator studying necrotic enteritis in swine to follow what the bacteriologist or chemist somewhere else is finding out about black tongue in dogs, especially if he knows that the two animals have much in common in their exposure to infection and their general living and eating habits or if the two diseases seem to bear some resemblance to each other, even very superficial resemblance. Possibly it would be classified as little more than curiosity, when an investigator studying swine feeds and feeding methods and finding that a seemingly undue proportion of his experimental animals developed necrotic enteritis, began to think about the disorders of human beings living on similarly deficient diets—but curiosity, intelligently directed, is one of the most effective tools of the research worker. Anyway, here is the brief story of an intelligently-directed curiosity and of where it has led.

The Association of Necrotic Enteritis with a Dietary Deficiency—

In 1935 the Michigan Agricultural Experiment Station began a study of the "Effect of rations made up largely of single grains on growth and quality of meat produced by swine". This is essentially a quality-of-pork investigation, some of the more specific objectives being to determine the influence of certain feeds on total percentages and manner of deposition of fat, and on thickness of alternating layers of lean and fat tissue. More or less necrotic enteritis was encountered in the course of the study and the disorder was especially troublesome in lots that were fed certain rations. This has been true not just once but with lot after lot maintained on certain rations and led to the suspicion that some dietary deficiency in the one series of rations might be a major contributing cause, if not fully responsible for the disorder. Furthermore, the basic resemblance of these particular rations, chemically, with those of large numbers of people in areas where pellagra is prevalent, led to the further belief that the latter disease in humans and necrotic enteritis in swine may be comparable, even though entirely unrelated, disorders. If this is so, the workers reasoned, supplementing these deficient swine rations with some of the same food materials (e. g. yeast and fresh beef liver) found by University of Cincinnati and other investigators to alleviate pellagra in human beings should similarly prevent or cure necrotic enteritis in swine. A subsequent series of feeding trials confirmed this hypothesis. This did not prove that necrotic enteritis in swine is due to a dietary deficiency and to a dietary deficiency alone but it did definitely establish it as in part a nutritional disorder, that it is likely to develop or not to develop depending on the nature of the food supply.

While these experiments on the influence of rations on the quality of pork or on necrotic enteritis in swine (call them whichever one chooses) were in progress, some feeding experiments with dogs were

being conducted at the University of Wisconsin. It was found that the same special foods—viz. yeast and beef liver—that were effective in curing pellagra in human beings, were likewise effective in curing black tongue in dogs. The biochemists in Wisconsin also found that the potency of yeast or of fresh beef liver in curing or in preventing black tongue in dogs closely parallels the nicotinic acid content, that substance apparently being the particular ingredient or fraction that is active in this respect. The Wisconsin discoveries showing the relation between the nicotinic acid content of the ration and black tongue in dogs at once suggested to the Michigan investigators—Messrs. G. K. Davis, V. A. Freeman and L. L. Madsen—the desirability of testing that substance as a preventive and remedial treatment for necrotic enteritis in swine. Again the results of a series of recent trials that have been conducted confirm the hypothesis as to a relationship between the two.

Nicotinic Acid Not a Cure-All—The inference should not be drawn that all common swine feeding rations should be supplemented with nicotinic acid in order to prevent necrotic enteritis. Many common foods contain minute quantities of nicotinic acid. However, comparatively few data are available as to the nicotinic acid content of different foods or as to the nicotinic acid content of the same food crop when grown under different conditions, on different soils and when cured or processed in different ways. Probably many ordinary swine rations contain sufficient quantities of this constituent; only when and where the rations do not, are supplements of nicotinic acid needed, and at present that need can only be determined by the appearance of symptoms of its deficiency disease—a necrotic enteritis. Very possibly the disorder has appeared and disappeared from time to time and has occurred locally here and there or has been of more widespread or epidemic occurrence, depending on conditions which have or have not favored an adequate supply in the normal feeding ration. In other words, nicotinic acid has probably always been a factor in the prevention of this disease, though no one knew about it.

Furthermore, attention should again be called to the fact that it has not been shown that necrotic enteritis in swine is solely a nutritional problem. It may still be regarded as a bacterial disease due to *Salmonella choleraesuis*, just as it has been regarded during recent years, and diet may serve only to prevent or to permit the development of the causal organism. Probably other organisms besides *S. choleraesuis* and other dietary constituents besides nicotinic acid are, at times at least, important in determining the incidence or the severity of attack. The sanitary measures heretofore recommended to hold the causal organism in check are fully as important in control as they were before the discovery of the relation of nicotinic acid to the disease. With the aid of this discovery, however, those engaged in swine raising can undoubtedly greatly reduce their death losses.

Finally, attention should be directed to the fact that this experimental work deals with the influence of a specific chemical constituent (nicotinic acid) of certain foods upon a specific disorder (necrotic enteritis). It is not always easy to distinguish necrotic enteritis from certain other diseases and difficulty may be increased if the animal is suffering from a combination of two or more disorders at the same

time. Nicotinic acid is not suggested as a preventative for any of these other troubles.

The reader who may be interested in a detailed account of the feeding trials which resulted in establishing the connection between necrotic enteritis in swine and nicotinic acid deficiency in the ration is referred to Technical Bulletin 170 of the Station—THE RELATION OF NUTRITION TO THE DEVELOPMENT OF NECROTIC ENTERITIS IN SWINE.—Davis, G. K., Freeman, V. A. and Madsen, L. L. The farmer who wishes brief directions for the supplementary feeding of swine may address a request to the Department of Animal Husbandry, Michigan State College, East Lansing, Mich.

V. R. GARDNER,
DIRECTOR,
MICHIGAN AGRICULTURAL EXPERIMENT STATION.

FINISHING LAMBS ON DIFFERENT PROPORTIONS OF CORN AND ALFALFA

LEONARD H. BLAKESLEE AND G. A. BROWN
SECTION OF ANIMAL HUSBANDRY

Lamb feeders in Michigan find it necessary to adjust their feeding methods to the supply of hay and grain available. Compliance with the Soil Conservation Program increases the amount of roughage available for feeding. The question of how large a proportion of roughage a lamb can consume and still take on a good marketable finish is debatable. Some feeders contend that a ration consisting of as little as 30 per cent grain is ample for fattening a lamb. A second question is that of death losses. Many lambs cannot take a heavy feed of grain, hence death losses may be great when a large amount of corn or other grain is being fed. A third consideration is the effect of self-feeding ground hay and grain on feed consumption and the gains obtained.

In the trials herein reported, four lots of lambs were fed, the plan being to feed two lots approximately equal quantities of corn and hay, Lot 1 being hand-fed and Lot 7, self-fed. Two other lots, 3 and 5, were fed similarly, but given 70 per cent hay and 30 per cent roughage.

Table 1 gives the results of these trials: The lambs in Lot 1, hand-fed approximately equal parts of shelled corn and alfalfa hay, gained 34.8 pounds per head, or 0.33 of a pound daily, whereas Lot 3, fed 70 per cent hay and 30 per cent grain, gained 31.6 pounds per head, or 0.3 pound per lamb daily. Lot 7, self-fed equal quantities of hay and grain, gained 38 pounds per head, or 0.36 of a pound daily, whereas Lot 5, self-fed 70 per cent hay and 30 per cent grain, gained 35 pounds per head, or 0.34 pound daily. The gains in all four lots were satisfactory. In amounts of feed required per hundredweight of gain, Lot 1, hand-fed equal parts of hay and grain, required 441 pounds of hay and 361 pounds of corn, whereas Lot 3, given a limited allowance of corn and a heavy feed of hay utilized 669 pounds of hay and 256 pounds

Table 1. Comparisons of different proportions of grain and hay, self-fed and hand-fed. (Summary of 2 trials—1937-38, 1939-40.)

	1 Hand-fed	7 Self-fed	3 Hand-fed	5 Self-fed
Number of lambs	38	36	38	40
Average number days fed	103	104	103	103
Average initial weight—lb	53.47	53.67	53.29	53.37
Average final weight—lb	88.28	91.68	84.90	88.59
Average gain per lamb—lb	34.80	38.01	31.60	35.22
Average daily gain per lamb—lb	0.33	0.36	0.30	0.34
AVERAGE DAILY RATION:				
Long alfalfa—lb	1.48	0.82*	2.04	0.84*
Ground alfalfa—lb		1.33		2.05
Cracked corn—lb		1.33		0.88
Shelled corn—lb	1.21		0.78	
FEED FED PER CWT. GAIN:				
Long alfalfa—lb	440.76	13.88	669.41	15.61
Ground alfalfa—lb		365.33		601.31
Cracked corn—lb		365.33		257.69
Shelled corn—lb	360.98		256.50	
FEED FED PER LAMB:				
Long alfalfa—lb	153.41	5.28	211.57	5.5
Ground alfalfa—lb		138.88		211.83
Cracked corn—lb		138.88		90.78
Shelled corn—lb	125.64		81.07	
Average dressing per cent (hot weight)	49.45	48.56	46.05	45.16

*Lots 7 and 5 were fed long alfalfa one week only at the start of the feeding period.

of shelled corn, in making each hundred pounds of gain. In the self-fed lots, it was possible to regulate accurately the proportion of hay and grain consumed. Lot 7 consumed 379 pounds of hay and 365 pounds of corn and Lot 5, 617 pounds of hay and 258 pounds of corn for each hundredweight of gain. In amounts of feed consumed, each lamb in Lot 1 consumed 153 pounds of hay and 125 pounds of corn. Each lamb in Lot 7, self-fed the same feeds, consumed 144 pounds of hay and 139 pounds of corn. Lot 3, receiving a heavy hay allowance and light corn allowance, consumed 211 pounds of hay and 81 pounds of corn, while Lot 5, self-fed the same proportion of hay and roughage, consumed 217 pounds of hay and 91 pounds of corn.

Feed Cost Per Hundredweight Gain

With corn at \$25 per ton and hay at \$10 per ton, the feed cost per hundredweight of gain was \$6.71 with Lot 1, receiving equal parts of hay and grain and \$6.56 with Lot 3, receiving 70 per cent hay and 30 per cent grain, a saving of \$0.15 per hundredweight of gain where the larger amounts of hay were fed. In Lot 7, self-fed equal parts of hay and grain, the feed cost per hundredweight of gain was \$6.46 and in Lot 5, self-fed 70 per cent hay and 30 per cent corn, the cost was \$6.30 per hundredweight of gain. At these prices, the differences in feed cost per hundredweight of gain is not great. Another significant feature of these trials is the saving effected by grinding the feed. In the case of equal parts of hay and roughage in Lots 1 and 7, there was a saving of \$0.25 per hundredweight of gain by grinding. This would offset the cost of grinding of 365 pounds of each of hay and corn. In the case of Lots 3 and 5, fed 70 per cent hay and 30 per cent corn, there

Table 2. Feed cost per hundredweight gain with hay and corn at varying prices.

Lot 1—Hand-fed
Lot 7—Self-fed

Corn at	Hay at \$5.00 per ton		Hay at \$7.50 per ton		Hay at \$10.00 per ton		Hay at \$12.50 per ton	
	Lot 1	Lot 7	Lot 1	Lot 7	Lot 1	Lot 7	Lot 1	Lot 7
.42 per bushel	\$3 81	\$3.68	\$4 36	\$4 16	\$4.91	\$4 64	\$5.46	\$5.11
.56 per bushel	4 71	4 59	5 26	5 07	5 81	5.55	6.36	6.02
.70 per bushel	5 61	5 50	6 16	5 98	6.71	6.46	7 26	6 93
.84 per bushel	6 51	6.41	7 06	6 89	7.61	7.37	8.16	7.83

Lot 3—Hand-fed
Lot 5—Self-fed

Corn at	Lot 3	Lot 5	Lot 3	Lot 5	Lot 3	Lot 5	Lot 3	Lot 5
.42 per bushel	\$3.59	\$3 46	\$4 43	\$4 24	\$5.27	\$5.02	\$6.10	\$5.79
.56 per bushel	4 23	4 10	5 07	4.88	5.91	5.66	6.74	6.43
.70 per bushel	4.88	4.75	5 72	5.53	6.56	6.31	7.39	7.08
.84 per bushel	5.52	5 40	6.36	6.17	7.20	6.95	8.03	7.72

was a saving of \$0.25 in cost per hundredweight of gain as a result of grinding and self-feeding. In other words, \$0.25 was saved by grinding 601 pounds of hay and 258 pounds of corn. In both of the above-mentioned comparisons, however, the self-fed lambs gained more rapidly than did the hand-fed lambs.

Finish

All the lambs made satisfactory gains, varying from 31 to 38 pounds per lamb in 103 days. There was a sufficient difference in dressing percentage to indicate considerable advantage in value for the lambs which were fed the larger proportion of corn. Lot 1, hand-fed equal parts of corn and hay, dressed 49.45 per cent, whereas Lot 3, hand-fed 30 per cent corn and 70 per cent hay, dressed but 46.05 per cent, a difference of 2.4 per cent in favor of the heavy grain feeding. With dressed lambs selling for 16 cents per pound, Lot 1 was worth 38 cents more per hundredweight alive than was Lot 3, fed a large quantity of roughage. Lot 7, self-fed equal parts of hay and corn dressed 48.56 per cent, whereas Lot 5, self-fed 70 per cent hay and 30 per cent corn, dressed 45.16 per cent, a difference of 3.4 per cent in favor of the lot receiving the heavier corn allowance. In this case, with dressed lambs worth 16 cents per hundred pounds, Lot 7, self-fed the larger proportion of grain, would be worth 54 cents more per hundredweight.

Summary

1. Lambs hand-fed 70 per cent of hay and 30 per cent corn gained 3.2 pounds less than similar lambs self-fed 50 per cent hay and 50 per cent corn. The saving per hundredweight of gain was only \$0.15 with hay at \$10 per ton and grain at \$25 per ton. Lambs receiving the greater proportion of corn dressed 2.4 per cent higher making them worth \$0.38 more per hundred pounds live weight when dressed lambs are worth \$16 per hundredweight.

2. Lambs self-fed 70 per cent of hay and 30 per cent corn gained 3 pounds less than similar lambs self-fed 50 per cent hay and 50 per cent corn. The saving was \$0.16 per hundredweight of gain in favor of the lambs receiving 70 per cent of hay. In this case, the dressing yield was 3.4 per cent to the advantage of the lambs receiving 50 per cent grain and 50 per cent corn, making them worth 54 cents more per hundred pounds live weight.

3. Self-feeding of ground hay and corn rations saved \$0.25 per hundredweight of gain in comparison to hand-feeding a similar ration. This saving of \$0.25 per hundredweight of gain would allow 3.4 cents per hundredweight for grinding hay and grain when a 50-per cent hay ration was fed. When a 70-per cent hay ration was fed, grinding could be charged at 2.9 cents per hundredweight to equal costs of a similar hand-fed ration.

pH VALUES OF CREAM, BUTTER AND BUTTERMILK AS AFFECTED BY DIFFERENT NEUTRALIZERS

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In an effort to obtain greater uniformity in the quality of butter, pH determinations of cream and butter sera have come into practice as a control measure in buttermaking and have been suggested as being more reliable and accurate than titration methods. While studying the relationship of the above-mentioned values to the acidity of cream treated with different neutralizing agents (2, 3), data were also gathered on the pH of the corresponding buttermilk. Such data are presented in this paper.

Hunziker and Cordes (1) found that the pH values of butter and buttermilk were identical up to 6.7, but above this the pH of the butter was higher than that of the buttermilk. In addition, these workers noted a close agreement between the pH of the cream and that of the buttermilk.

Experimental

The experimental procedure has been presented elsewhere (2, 3). Briefly, the procedure consisted of neutralizing cream of approximately 0.5 per cent acidity to calculated acidities ranging from 0.00 to 0.25 per cent using sodium carbonate, Recto (a mixed soda neutralizer), sodium hydroxide, Wyandotte C. A. S. (a mixed soda neutralizer), calcium lime and magnesium lime. The acidity and pH of the cream was determined at churning and the pH of the buttermilk and butter serum was determined soon after completing the churning of each lot of cream. The results of this study are presented in Table 1.

These results show that cream neutralized to each of the desired acidities with the various neutralizers varies considerably in pH. There is a relatively uniform relationship in pH of the cream to the pH of

Table 1. The influence of the different neutralizers on the pH of the Cream, Butter and Buttermilk.*

Neutralizer used	Desired acidity	pH Values		
		Cream at churning	Butter-milk	Butter serum
Sodium Carbonate	0.25	6.00	5.86	6.06
	0.15	6.48	6.35	6.62
	0.10	6.70	6.70	7.02
	0.05	6.95	6.84	7.07
	0.00	7.14	7.04	7.33
Recto	0.25	6.27	6.12	6.39
	0.15	6.47	6.63	7.03
	0.10	7.04	6.88	7.30
	0.05	7.17	7.05	7.48
	0.00	7.33	7.25	7.60
Sodium Hydroxide	0.25	6.40	6.31	6.54
	0.15	7.15	7.01	7.25
	0.10	7.26	7.12	7.47
	0.05	7.69	7.50	7.73
	0.00	8.01	7.73	7.85
Wyandotte C. A. S.	0.25	6.26	6.06	6.55
	0.15	6.95	6.66	7.01
	0.10	7.03	6.86	7.21
	0.05	7.26	7.11	7.44
	0.00	7.43	7.30	7.70
Calcium Hydrated Lime	0.25	6.07	5.92	6.33
	0.15	6.46	6.42	6.71
	0.10	6.63	6.65	7.05
	0.05	6.95	6.80	7.62
	0.00	7.70	7.58	7.89
Magnesium Oxide Lime	0.25	6.20	6.16	6.71
	0.15	6.36	6.39	6.84
	0.10	6.82	6.70	7.29
	0.05	7.52	7.42	7.64
	0.00	—	7.67	7.97

*Average of three or more series of trials.

the buttermilk and butter sera regardless of the neutralizer used. Over the entire range of acidities studied, the pH of the buttermilk persisted at approximately 0.10 unit less than the pH of the cream and the butter sera persisted at a value approximately 0.15 unit above the pH of the cream from which it was made.

An exception to the general relationship of pH values is apparent in the case of cream neutralized with either calcium hydrated lime or magnesium oxide lime. Although the pH of the butter sera was found to exceed the pH of the cream in every case the pH of the buttermilk was found to be practically the same as the pH of the corresponding cream between pH 6.4 and 6.6 when calcium lime was used and between pH 6.2 and 6.4 when magnesium lime was employed. Likewise, when Recto was used the pH of the buttermilk exceeded the pH of the corresponding cream only when the cream was neutralized to a desired acidity of 0.15 per cent.

The typical relationship of the pH values of cream, butter sera and buttermilk for a lime and soda is presented in Fig. 1. When either type of neutralizer is used the pH of the butter sera is higher than the pH of the cream or buttermilk. Similarly, the pH of the cream is higher than the pH of the buttermilk except when cream is neutralized to acidities of 0.10 to 0.15 per cent with a lime neutralizer.

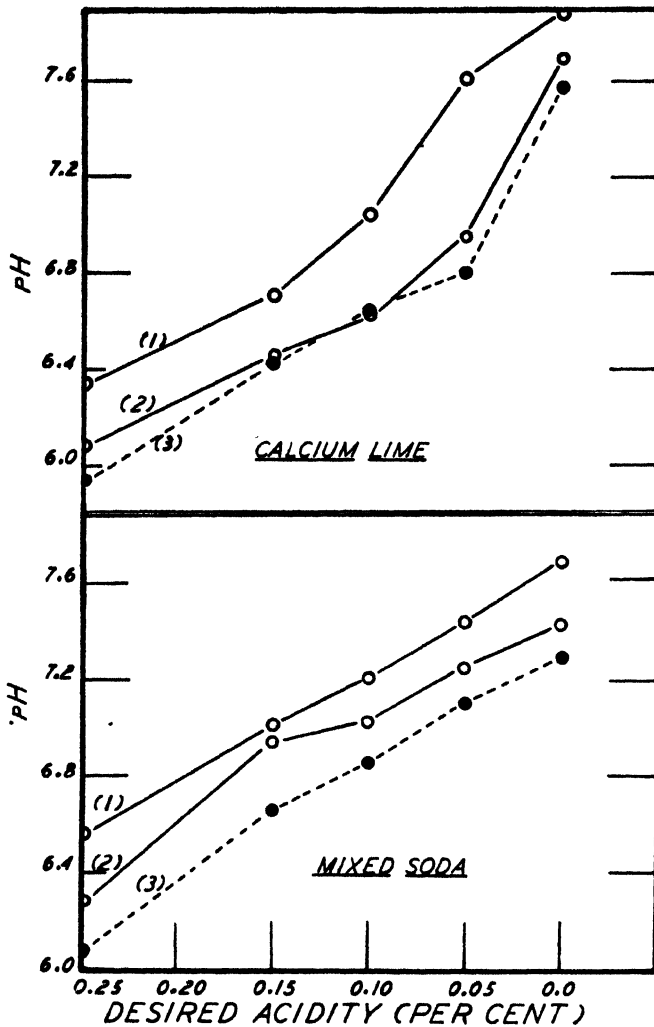


Fig. 1. The relationship of the pH values of cream, butter serum and buttermilk when cream is neutralized with calcium lime and a mixed soda.

Curve (1)—Butter serum
Curve (2)—Cream
Curve (3)—Buttermilk

Summary

The pH of butter sera and buttermilk persists at a relatively uniform relationship to the pH of the corresponding cream when different neutralizing agents are employed in the neutralization of cream of approximately 0.5 per cent acidity to an acidity range of 0.00 to 0.25 per cent. In general, the pH of butter sera is approximately 0.15 pH

unit above and the pH of the buttermilk is approximately 0.10 pH unit lower than the corresponding cream.

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THE EFFECT OF REPLACING SOLVENT-EXTRACTED SOYBEAN OIL MEAL WITH SOYBEANS IN A LOW FAT RATION

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A ration consisting of mixed hay, barley and solvent-extracted soybean oil meal is especially adapted for feeding dairy cattle in the Upper Peninsula of Michigan. Hay and barley are home grown feeds, and solvent-extracted soybean oil meal is commonly used as a protein supplement. This type of ration is low in fat. In view of the work of Maynard and associates (1, 2) which indicated that the concentrate mixture should contain about 4 per cent fat, a long time experiment was started to determine the effect on milk and fat production of replacing the solvent-extracted soybean oil meal with soybeans in order to increase the fat to about 5 per cent of the grain mixture.

The Holstein herd at the Upper Peninsula Experiment Station had received for several months a concentrate mixture consisting of barley and solvent-extracted ground soybean oil meal as a supplement to mixed hay and grass silage made from a mixture of alfalfa and timothy. The herd was divided into two groups. The cows in group I (6 cows) were changed to the following concentrate mixture on January 11: 500 pounds ground barley, 100 pounds of ground soybeans, iodized salt and special steamed bonemeal. This mixture contained 4.75 per cent fat. The cows in group II (5 cows) were fed the following concentrate: 600 pounds of ground barley, 100 pounds of solvent-extracted soybean oil meal, iodized salt and special steamed bonemeal. This concentrate mixture contained 1.3 per cent fat.

The chemical composition of the feeds used in this investigation is shown in Table 1.

Inasmuch as the herd had been receiving a ration low in fat for several months, a change of the cows in group I to a ration high in fat was expected to result in an increase in milk production. The data presented in Table 2, however, show that the change from a concentrate containing 1.3 per cent fat to one containing 4.75 per cent fat

Table 1. Chemical composition of feeds used.*

	Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract
Hay—mixed.....	9.0	1.73	35.0	41.0
**Grass silage.....	6.4	1.54	8.8	13.8
Group I (concentrate mixture).....	17.4	4.75	7.8	53.3
Group II (concentrate mixture).....	18.7	1.30	7.1	55.4
Barley.....	13.1	1.90	9.3	59.7
Soybeans.....	36.7	18.41	4.4	24.0
Soybean oil meal.....	45.9	7.4	5.4	30.0

*The chemical data were furnished by the Section of Chemistry.

**Moisture 66.3 per cent.

did not affect milk, fat or the 4 per cent fat-corrected milk of the cows in group I.

Table 2. Effect of changing from ration low in fat to a ration high in fat.

Date—5-day Periods	Group I			Group II		
	BASAL RATION (Concentrate Mixture containing 1.3 per cent Ether Extract)			BASAL RATION (Same as that fed Group I)		
	Milk Average daily pounds	Test per cent	4 per cent F. C. M.* Average daily pounds	Milk Average daily pounds	Test per cent	4 per cent F. C. M.* Average daily pounds
Dec. 27-31.....	46.2	3.4	42.0	44.8	3.5	41.6
Jan. 1-5.....	48.2	3.2	42.7	45.7	3.3	41.2
Jan. 6-10.....	49.5	3.1	43.0	46.7	3.3	41.6
	Group I changed to concentrate mixture containing 4.75 per cent ether extract**					
Jan. 11-15.....	47.1	3.3	42.1	45.0	3.5	42.0
Jan. 16-20.....	47.2	3.3	42.6	44.4	3.4	40.7
Jan. 21-25.....	46.3	3.3	41.4	43.8	3.5	40.7
Jan. 26-30.....	45.9	3.3	41.2	44.5	3.4	40.7
Jan. 31-Feb. 4.....	44.5	3.6	40.2	43.5	3.5	40.1
Feb. 5-9.....	44.1	3.4	39.6	43.7	3.4	40.2

*4 per cent fat-corrected milk equals 0.4 milk plus 15 fat.

**Soybeans replaced soybean oil meal.

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STATE SUMMARY OF "ANNUAL FARM SUCCESS FACTOR REPORTS" ON 1,346 MICHIGAN FARMS—1939

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The Farm Management Department of Michigan State College and the county agricultural agents in 77 counties again sponsored the extension project in farm accounting for 1939. A total of 1,497 farm account books were summarized, which is the largest number of records closed for any single year since the project was started in 1929. This state summary is based on 1,346 records, however, because 151 of the 1,497 records were either received too late or because they were not comparable for one reason or another.

Since Michigan has much variation in its agriculture it is necessary to study the state by areas. Thus, a report was prepared for each of the type-of-farming areas (see Fig. 1), with the exception of Area 13. These reports were based on the farm account books kept in the different areas.

All records were carefully checked by representatives of the Farm Management Department before being summarized. Most of the checking was done in the presence of the farmer-cooperator. Each cooperator then received a copy of the appropriate area report with his own farm figures tabulated. In addition, each cooperator who had been in the project less than 6 years received a summer visit from the farm management specialist accompanied by the local county agricultural agent. Thus, the farmer had an opportunity to compare his farm business with the average of other farms of similar type and size, as well as with more and less successful farms. By determining the strong and weak points in his business he has a basis for making adjustments needed in order to increase the farm income.

Farm Earnings in 1939

Farm earnings in Michigan averaged 37 per cent higher in 1939 than in 1938. With the exception of 1936 the 1939 earnings were the highest of any year since the Farm Accounting Project started in 1929.

The average labor income in 1939 was \$780 for the 1,346 farmers keeping records. This earning figure represents what the operator of the farm has left for his labor and management after paying all cash operating expenses, allowing for depreciation and other inventory losses, charging for family labor, other than his own, at hired wage rates, and deducting 5 per cent interest on the investment. This earning figure does not give the farm credit for the value of home-grown farm produce used by the household. Table 1 shows a comparison of

*E. B. Hill and L. H. Brown of the Farm Management Department and the county agricultural agents in 77 counties assisted with this project.

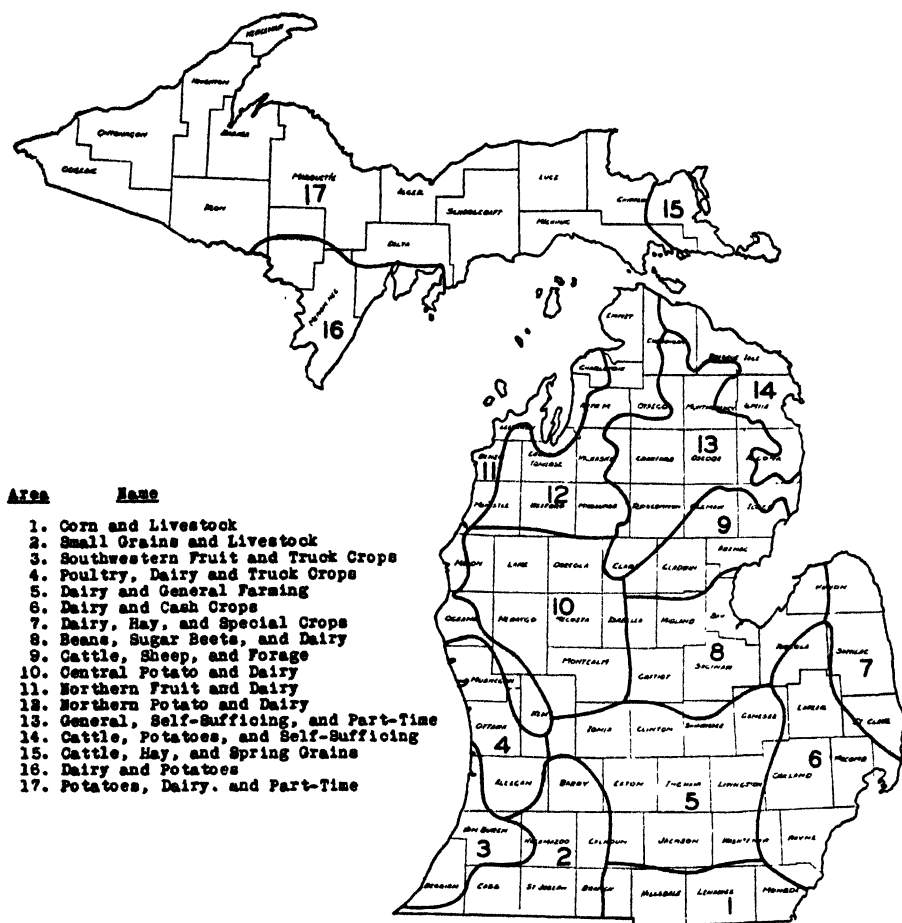


Fig. 1. Type of farming areas in Michigan.

average farm earnings for farm account cooperators in the state for the 11 years, 1929-39.

The increased earnings in 1939 over those of 1938 were largely due to greater returns from crops. The returns from cattle, sheep, and agricultural conservation payments were also greater than in 1938. (In some instances the income from 1939 agricultural conservation payments included both 1938 and 1939 payments.) Crop yields in general did not increase in 1939. Corn and oat yields averaged a little higher, potato and sugar beet yields were lower, while other yields were about the same as in 1938. The greater returns from crops were largely due to higher prices for most feed and general cash crops during the latter part of 1939. Sugar beets brought slightly less per ton in 1939. The price of alfalfa seed was also lower but clover seed brought more than in 1938. Fruit prices were again unfavorable. The peach crop was good and thus provided relatively better returns than other fruits

Table 1. Eleven-year comparison of financial returns on Michigan farm-account farms, 1929-39.

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	11-year average
Number of farms.....	427	771	925	831	795	845	933	1,055	1,163	1,252	1,346	940
Total acres.....	159	162	163	156	154	157	164	161	158	163	165	160
Tillable acres.....	107	111	109	103	108	103	107	106	104	108	108	106
Average investment.....	\$16,980	\$17,264	\$15,859	\$12,974*	\$11,813	\$12,192	\$12,510	\$12,502	\$12,904	\$13,024	\$13,150	\$13,743
Cash receipts.....	\$ 3,600	\$ 3,373	\$ 2,990	\$ 1,805	\$ 1,825	\$ 2,389	\$ 2,826	\$ 3,353	\$ 3,358	\$ 2,989	\$ 3,195	\$ 2,827
Cash expenses.....	2,351	2,128	1,487	1,088	1,000	1,324	1,668	1,869	2,101	1,841	1,926	1,707
Net cash income.....	1,249	1,245	1,503	717	825	1,065	1,158	1,484	1,257	1,148	1,269	1,120
Net change in inventory.....	354	-430	-320	-324	153	252	398	650	155	284	386	105
FARM FAMILY INCOME.....	\$ 1,603	\$ 815	\$ 292	\$ 193	\$ 978	\$ 1,317	\$ 1,556	\$ 2,134	\$ 1,412	\$ 1,432	\$ 1,655	\$ 1,225
Less: Unpaid family labor.....	259	215	175	139	138	142	166	191	198	210	218	186
NET FARM INCOME.....	\$ 1,434	\$ 600	\$ 117	\$ 54	\$ 840	\$ 1,175	\$ 1,390	\$ 1,943	\$ 1,214	\$ 1,222	\$ 1,437	\$ 1,039
Less: Operator's labor.....	671	667	546	423	420	418	432	538	528	528	525	518
Return for investment and management	\$ 763	\$ -67	\$ -429	\$ -369	\$ 420	\$ 757	\$ 958	\$ 1,405	\$ 686	\$ 694	\$ 912	\$ 521
RATE EARNED ON INVESTMENT, per cent.....	4.49	- 39	-2 70	-2 84	3.56	6.21	7 66	11.24	5.32	5 33	6 94	4 07
NET FARM INCOME.....	\$ 1,434	\$ 600	\$ 117	\$ 54	\$ 840	\$ 1,175	\$ 1,390	\$ 1,943	\$ 1,214	\$ 1,222	\$ 1,437	\$ 1,039
Less: Interest at 5%.....	849	863	793	649	591	610	626	625	645	651	657	687
LABOR INCOME.....	\$ 585	\$ -263	\$ -676	\$ -595	\$ 249	\$ 565	\$ 764	\$ 1,318	\$ 569	\$ 571	\$ 780	\$ 352

*Land values were deflated approximately 25 per cent at the beginning of 1932

even though the price received was much lower than in 1938. Truck crops brought in less in 1939 for all crops except cabbage, carrots, early celery, and strawberries.

The income from livestock was slightly greater in 1939 with the returns from cattle and sheep causing most of the increase. Returns from feeder cattle were generally good during the early part of 1939, while in the fall conditions were less favorable. Returns from feeder lambs were generally good, although prices for lambs that went into the feed lots in the fall were higher than for those that went in during the fall of 1938. Incomes from cattle other than feeders, stock sheep, and wool were good throughout the year. The returns per cow from dairy products were about the same for both years although 1939 prices averaged slightly lower. The hog situation was unfavorable, with prices averaging the lowest for any of the last five years. The poultry and egg situation was also unfavorable with feed prices being higher and poultry and egg prices lower than the year before.

The cash receipts per farm increased from \$2,989 in 1938 to \$3,195 in 1939 (see Table 1) or an increase of 7 per cent. Most of this increase was due to slightly greater returns from crops, cattle, and agricultural conservation payments. The cash expenses per farm increased from \$1,841 in 1938 to \$1,926 in 1939. The average total farm inventory increased \$386 between the beginning of 1939 and the end of the year. The feed inventory showed the largest increase, with cattle, machinery, and farm improvements also showing increases.

When the cash receipts and cash expenses are combined with non-cash expenses and inventory changes, then the total farm income and total expenses can be obtained. The total income, expenses, and also investments for the average of the 1,346 farms are itemized and shown in Figs. 2, 3, and 4.

Farm Investments

The capital investments averaged \$13,150 per farm for the 1,346 farms included in this report in 1939. Fig. 2. indicates the various investment items and the amount and percentage that each item is of the total investments.

AVERAGE OF 1,346 FARMS	
Land	\$ 5,060
Improvements (less house)	3,454
Livestock	1,786
Machinery	1,474
Feed	890
Orchard	486
TOTAL INVESTMENTS	\$13,150

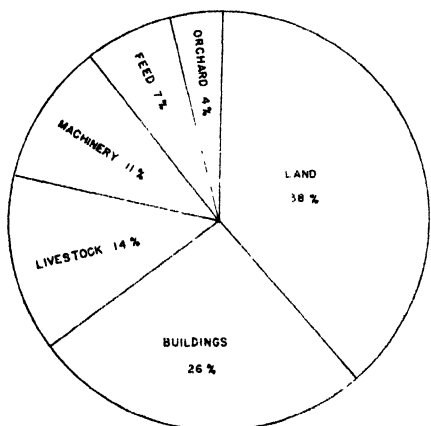


Fig. 2. Percentage of total investments in various items on the average of 1,346 Michigan farms, 1939.

Farm Receipts

The gross income averaged \$2,960 per farm in 1939. Figure 3 shows the gross income and the relative importance of the different sources of income for 1939.

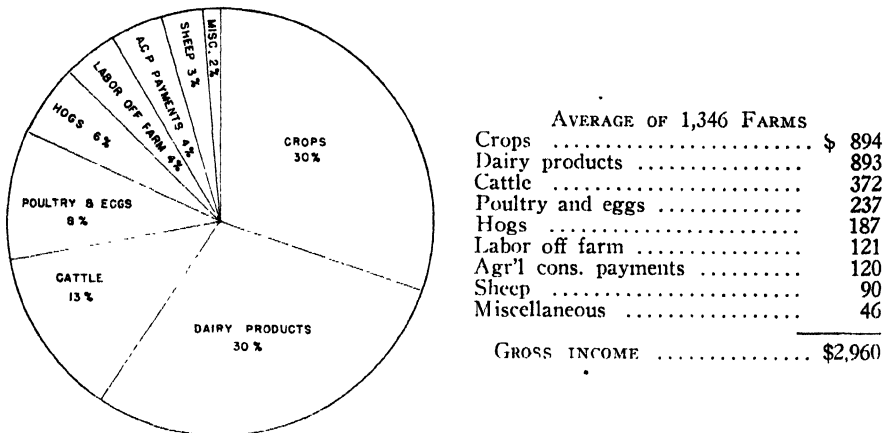


Fig. 3. Percentage of gross income from various sources on the average of 1,346 Michigan farms, 1939.

Farm Expenses

The total expenses averaged \$2,048 per farm in 1939. Figure 4 shows the various expense items and the amount and percentage that each item is of the total expenses.

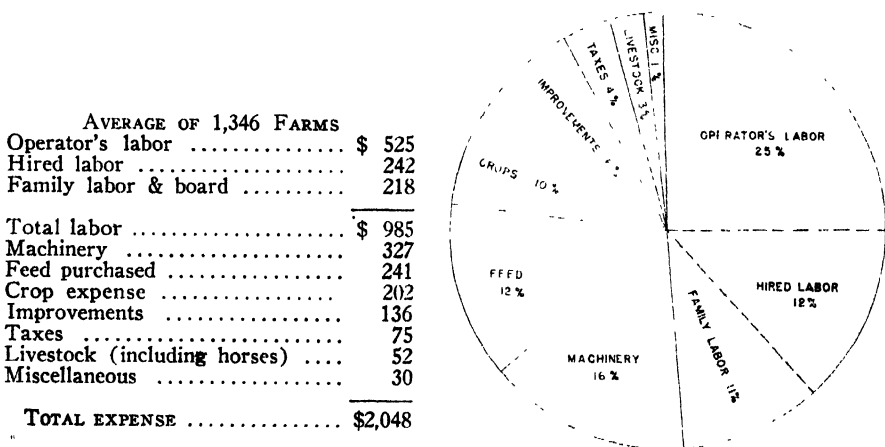


Fig. 4. Percentage of total expenses for various items on the average of 1,346 Michigan farms, 1939.

Change in General Level of Farm Incomes

Farm earnings vary greatly on the average of all farms from year to year. This is shown by over 10,000 individual farm records kept by farmers in cooperation with the Farm Management Department during the last 11 years, 1929-39 (see Fig. 5, and Table 2). Farm earnings averaged "in the red" for each of the years 1930 to 1932, showed gradual improvement from 1933 to 1936, averaged about the same in 1937 and 1938 as in 1934, and then showed some improvement again in 1939.

Table 2. Percentage distribution of labor incomes by years, 1929-39.

Year	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	11-year av.
Number of farms	427	771	925	831	795	845	933	1,055	1,163	1,252	1,346	940
Labor income	Percentage of farms in each income group											
\$1,001 or more	25%	6%	1%	1%	10%	23%	31%	51%	24%	23%	32%	21%
1 to 1,000	52	32	16	12	55	56	56	43	54	57	54	44
0 or less	23	62	83	87	35	21	13	6	22	20	14	35

What causes this year-to-year variation in farm earnings? Changes in farm organization and management and variations in crop yields and animal production are important factors on individual farms. But, the most important factor causing this annual variation in farm earnings is the general price level. When the general price level changes, the prices of basic commodities, such as wheat, corn, pork, butter, and wool change quickly. But, many costs of operating a farm cannot be adjusted so quickly. Wages, taxes, debts, retail prices, and overhead

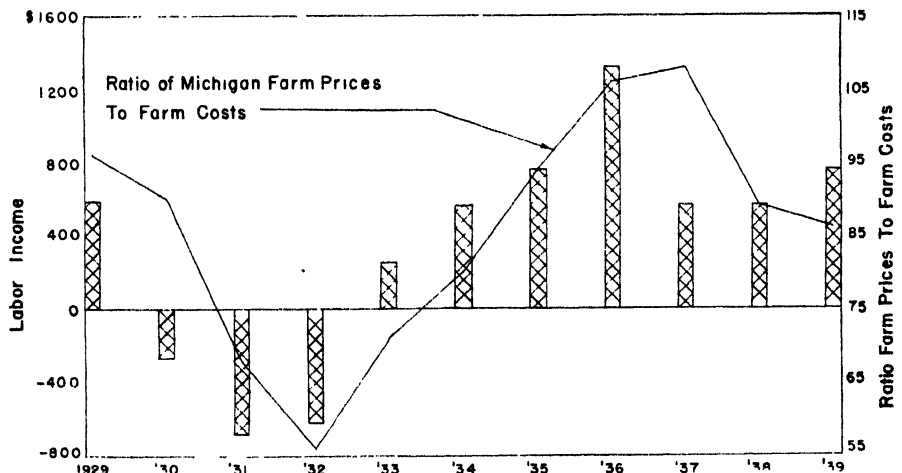


Fig. 5. Relationship between the ratio of Michigan farm prices to farm costs and labor incomes, 1929-39.

costs change very slowly. Therefore, farmers are benefited by rising prices but are adversely affected by falling prices. That the course which commodity prices take and the adjustment of farming costs to them has an important influence on farm incomes is shown in Fig. 5.

Variation in Individual Incomes Each Year

Individual farm incomes vary greatly under the same price conditions (Fig. 6). Most of the important factors causing the great variation in earnings on farms for any one year are under the control of the farmer. Such factors as size of business, cropping program, livestock program, combination of enterprises, and efficiency in the use of labor and capital are some factors over which the farmer has considerable control.

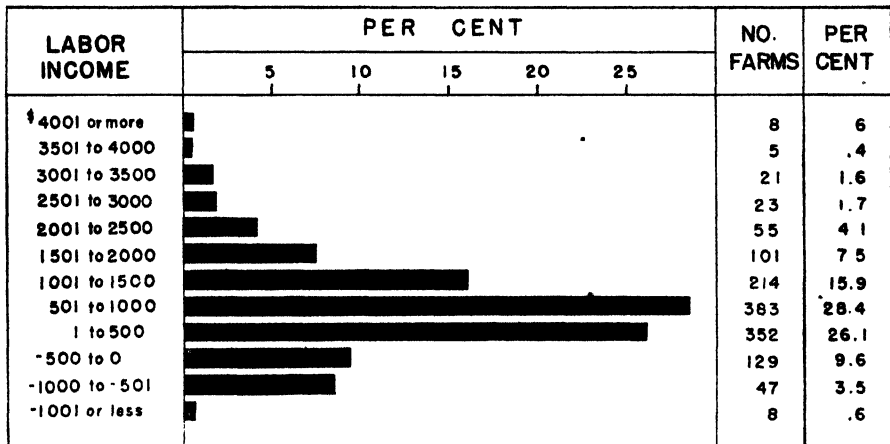


Fig. 6. Distribution of labor incomes on 1,346 Michigan farms, 1939.

Farming is an occupation which usually amounts to providing the farm operator and his family with jobs. Of the 1,346 farm operators represented in this report, more than 70 per cent received between \$1 and \$1,500 for their labor and management during 1939.

State and Area Averages

The accompanying tables, 3, 4, 5, and 6 indicate that farm earnings vary considerably between different areas in any one year. Also, the areas do not retain the same relative position in earnings year after year (see bottom Table 3). Factors beyond a farmer's control will cause changes in the relative position. These tables show percentages of tillable land in various crops, crop yields, livestock inventories, power and machinery costs, amounts of labor, and various other factors affecting farm earnings, as well as average income and expense figures.

Table 3. Average financial summary, and crop and livestock figures on 1,346 Michigan farms by type-of-farming areas, 1939.

Type-of-farming Area	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
All Farms	1,346	86	136	49	68	216	68	139	60	122	50	144	42	22	34	78
Number of farms	165	178	197	82	118	170	102	181	198	174	130	185	104	182	156	157
Total acres	80	69	73	84	81	76	76	83	71	86	92	89	92	81	96	95
Per cent of land owned	65	75	74	58	80	73	73	80	75	69	69	70	54	62	62	47
Per cent of farm area tillable	108	133	145	70	94	124	119	144	109	103	90	100	88	115	119	86
Capital Investments, total	\$13,150	\$16,179	\$10,011	\$16,693	\$12,198	\$15,193	\$16,047	\$15,586	\$15,663	\$9,379	\$11,092	\$15,485	\$8,693	\$9,512	\$9,757	\$8,246
Real estate (less house)	9,000	10,857	11,137	13,533	8,029	10,314	11,103	10,437	10,770	6,061	7,452	12,378	5,098	4,748	5,435	5,435
Machinery and equipment	1,474	1,737	1,498	1,737	1,341	1,634	1,590	1,601	1,601	1,088	1,254	1,713	1,075	1,046	1,142	1,235
Feed, crops and supplies	890	1,253	1,180	524	898	1,106	1,297	1,291	1,291	714	521	1,440	514	462	444	528
Livestock (includes horses)	1,786	2,572	2,190	794	1,920	2,168	2,287	2,217	1,910	1,734	1,622	891	1,271	1,376	1,418	1,161
Cash Receipts, total	\$3,195	\$4,304	\$2,738	\$4,150	\$3,211	\$3,817	\$3,531	\$3,259	\$3,810	\$2,132	\$2,724	\$3,652	\$1,815	\$2,980	\$2,515	\$2,040
Livestock sales, total (includes horses)	2,053	\$3,316	\$2,923	\$2,557	\$2,066	\$2,521	\$2,635	\$2,037	\$2,432	\$1,749	\$2,790	\$3,360	\$1,030	\$2,126	\$1,791	\$1,346
Crop sales	721	539	492	313	291	571	565	1,014	1,093	259	579	2,328	301	241	293	254
Agricultural conservation payments*	121	152	212	69	103	143	151	109	91	123	111	93	80	87	73	40
Labor off farm	120	110	112	69	86	102	78	144	130	155	108	120	112	136	164	219
Other receipts	200	271	240	155	194	205	188	355	255	165	157	145	119	170	226	181
Cash Expenses, total	\$1,926	\$2,738	\$2,477	\$2,904	\$1,983	\$2,087	\$1,940	\$2,190	\$2,070	\$1,306	\$1,592	\$2,451	\$965	\$1,563	\$1,395	\$1,166
Farm improvements	198	189	336	223	171	103	180	143	205	203	153	237	150	88	78	117
Machinery and equipment	575	644	558	659	523	597	635	919	725	429	544	660	441	339	476	531
Livestock purchases (includes horses)	327	739	556	136	251	432	202	408	311	324	226	121	171	157	308	119
Feed, light	241	417	364	184	437	262	213	170	192	96	187	141	147	77	276	255
Hired labor	242	339	258	794	217	191	236	151	211	83	210	725	198	109	168	132
Crop expense	222	222	185	796	169	200	231	243	221	75	152	417	125	79	141	129
Taxes	75	111	108	83	70	66	90	83	82	51	70	74	50	34	58	49
Other expenses	66	87	85	119	75	76	94	70	63	35	50	36	34	53	63	41
Net Change in Inventory	\$386	\$398	\$539	\$393	\$347	\$338	\$343	\$724	\$657	\$344	\$417	\$282	\$310	\$200	\$140	\$151
Improvements (includes orchard)	60	15	140	264	44	24	47	—5	109	104	121	151	50	7	—23	18
Machinery and equipment	101	50	74	106	94	110	102	212	197	100	143	103	64	64	73	90
Feed, crops, and supplies	165	306	235	49	164	166	161	468	327	66	147	140	16	41	—68	—5
Livestock (includes horses)	54	27	90	—21	45	38	33	50	64	74	106	—26	47	37	110	64
Net Cash Income	\$1,269	\$1,656	\$1,261	\$1,105	\$1,248	\$1,430	\$1,591	\$2,099	\$1,540	\$895	\$1,132	\$1,201	\$943	\$850	\$1,297	\$1,120
Plus: Inventory increase	336	398	539	398	347	338	343	724	657	344	417	282	310	200	140	\$74
Farm Family Income	1,605	2,054	1,800	1,503	1,595	1,768	1,934	2,793	2,077	1,240	1,549	1,483	1,253	1,053	1,437	1,200
Less: Unpaid family labor	218	192	179	228	222	206	237	252	199	222	202	199	164	211	213	354
Net Farm Income	1,437	1,862	1,621	1,335	1,373	1,562	1,697	2,541	2,098	949	1,315	1,281	1,084	810	1,226	810
Less: Operator's labor	525	564	572	531	560	573	590	576	548	454	521	479	444	460	445	460
Rate earned on investment (per cent)	6.94	8.02	6.55	4.81	6.51	6.90	6.90	12.61	9.32	7.20	5.18	7.02	4.60	8.84	6.06	6.06
Net Farm Income	\$1,437	\$1,862	\$1,621	\$1,335	\$1,373	\$1,562	\$1,697	\$2,541	\$2,098	\$949	\$1,315	\$1,281	\$1,084	\$810	\$1,226	\$810
Less: Interest at 5%	657	809	801	530	610	760	802	779	783	408	551	773	434	380	415	412
Labor income—1939	780	1,053	820	500	703	802	895	1,702	1,233	480	644	896	620	480	511	558
Labor income—1938	571	687	427	449	610	586	573	1,035	804	431	624	537	611	480	501	509

*Figures not comparable between areas because on some farms both 1938 and 1939 payments were received during 1939.

Table 4. Percentages of land in different crops and crop yields by type-of-farming areas, 1939.

Type-of-Farming Areas	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,345	85	136	49	68	216	68	33	139	60	122	50	144	42	22	34	78
Number tillable acres	108	133	145	70	94	124	119	144	109	85	103	90	100	88	115	69	59
Per cent tillable acres in hay, seed and pasture	47	41	46	37	43	44	46	45	33	58	51	55	55	55	61	57	65
Per cent tillable acres in legumes*	32	29	32	25	30	31	36	36	27	41	36	40	40	46	36	40	26
Per cent tillable acres in:																	
Tillable pasture	18	16	20	8	16	19	21	21	13	19	21	13	22	20	16	14	13
Alfalfa hay	15	13	13	9	13	15	15	11	15	26	19	15	21	21	18	12	10
Other hay	11	10	10	6	14	8	9	11	4	10	10	10	12	12	35	30	42
Corn	16	23	18	10	21	18	17	9	17	14	15	9	13	8	3	11	2
Wheat	7	10	11	5	10	10	6	9	7	2	5	2	3	3	3	1	1
Oats (oats and barley mixed)	11	11	7	6	13	13	14	13	11	12	10	6	8	8	12	11	13
Barley	3	2	1	—	2	3	3	3	8	3	1	1	1	1	4	8	7
Beans	3	—	—	0	1	4	1	1	11	3	—	—	—	—	1	0	0
Sugar beets	1	1	—	0	—	1	1	5	8	—	—	0	1	0	0	1	0
Potatoes	2	1	1	1	1	1	3	—	1	1	4	2	6	4	1	6	1
Fruit and truck	4	2	1	48	3	1	—	—	—	—	2	37	2	—	—	—	6
Other crops	9	11	18	7	4	8	7	6	4	9	10	8	11	13	20	5	6
Crop Yields per Acre:																	
Alfalfa hay	17	19	17	19	19	17	17	16	18	16	18	15	14	14	16	19	19
Other hay	14	15	14	13	15	13	13	14	15	11	14	12	11	11	11	17	16
Corn for silage	8	10	10	9	7	7	7	9	9	6	7	6	6	7	14	6	6
Corn (shelled)	43	54	51	49	39	40	41	38	41	35	41	36	35	28	20	17	9
Wheat	22	24	18	18	21	23	26	27	28	22	20	21	15	15	32	33	28
Barley	41	43	35	37	43	44	42	50	52	34	37	42	32	32	32	28	9
Oats	30	19	18	—	22	26	34	33	39	34	32	21	27	25	19	29	32
Beans	18	23	11	—	15	15	15	20	21	16	20	12	13	17	—	—	—
Sugar beets	8	9	—	—	7	8	4	9	9	9	8	—	—	—	—	7	—
Potatoes	136	100	144	114	109	99	104	128	100	138	141	138	167	133	86	138	118
Value crops produced per tillable acre	\$ 16.01	\$ 16.66	\$ 13.90	\$ 16.45	\$ 14.92	\$ 16.59	\$ 16.93	\$ 21.39	\$ 12.70	\$ 17.53	\$ 15.70	\$ 12.40	\$ 11.65	\$ 17.80	\$ 14.82	\$ 14.82	\$ 14.82
Crop sales	721	536	492	3,131	291	571	595	1,014	1,093	259	579	2,328	569	391	341	292	254
Feed bought	241	417	394	184	457	262	213	170	192	96	187	141	147	77	276	255	236

*Tillable land in tree fruits and vineyard is not included in this factor

Table 5. Kinds, amounts, and returns from livestock by type-of-farming areas, 1939.

Type-of-Farming Areas	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16 ^a	17
Farms																
Number of farms	1,346	85	135	68	216	68	33	139	60	122	50	144	42	22	34	78
Livestock income, total	\$1,780	\$2,696	\$2,235	\$2,374	\$2,002	\$2,397	\$2,302	\$1,796	\$1,244	\$1,659	\$804	\$1,254	\$928	\$1,923	\$1,767	\$1,323
Livestock income per tillable acre*	16.82	19.77	15.41	25.18	16.38	20.33	15.95	16.47	14.75	16.03	13.84	12.50	10.52	16.77	25.70	22.73
Productive animal units	21.9	31.6	27.3	22.4	27.1	23.9	24.5	22.8	22.5	20.4	11.3	16.7	16.4	17.8	18.5	16.3
Tillable acres per productive animal unit*	4.8	4.2	5.3	4.2	4.6	4.9	5.9	4.8	3.7	5.1	5.1	6.0	5.4	6.4	3.7	3.6
Cattle:																
Number of dairy cows	9.7	10.5	9.5	11.6	9.9	13.6	13.9	8.8	8.1	9.8	6.1	9.1	8.4	8.9	12.6	10.3
Dairy sales per cow	\$92	\$96	\$106	\$109	\$80	\$118	\$97	\$84	\$52	\$93	\$67	\$81	\$54	\$121	\$104	\$92
Dairy sales, total	893	1,010	1,041	1,256	893	1,614	1,344	739	425	907	410	736	460	1,077	1,312	950
Cattle income, total	372	546	423	383	425	416	678	400	421	367	192	281	275	325	309	220
Poultry:																
Number of hens	90	126	76	235	108	79	93	115	60	88	57	50	43	97	48	49
Egg production per hen	146	153	135	142	145	159	152	158	135	154	150	144	164	152	168	161
Egg sales per hen	\$2.10	\$2.05	\$1.70	\$2.31	\$1.99	\$2.34	\$2.00	\$2.03	\$1.55	\$1.93	\$1.59	\$1.58	\$1.37	\$3.07	\$2.24	\$2.25
Egg sales, total	181	262	129	551	214	184	187	234	93	170	91	79	58	299	108	111
Poultry income, total	237	379	178	616	301	231	217	292	149	212	127	135	78	400	118	128
Sheep:																
Number of ewes	10	13	14	1	23	6	3	9	26	7	1	5	8	5	1	1
Lambs raised per 100 ewes	90	90	58	80	84	93	100	98	92	93	113	96	112	101	125	83
Sheep income, total	\$90	\$189	\$132	\$7	\$199	\$46	\$28	\$92	\$156	\$54	\$8	\$32	\$57	\$60	\$4	\$4
Hogs:																
Number of sows	1.4	3.0	3.3	0.8	1.7	0.7	0.3	1.9	1.0	0.9	0.7	0.8	0.8	0.5	0.4	0.4
Number litters farrowed	2.5	5.5	8.1	1.4	3.0	1.2	0.5	3.5	1.7	1.6	1.1	1.3	1.3	0.9	0.6	0.6
Pigs weaned per litter	6.6	6.6	6.2	6.2	6.6	7.5	6.1	6.9	6.4	6.7	6.7	6.9	6.6	8.2	6.3	6.3
Hog income, total	\$187	\$485	\$493	\$113	\$234	\$90	\$35	\$274	\$92	\$118	\$65	\$70	\$58	\$57	\$24	\$21

^aTillable land in tree fruits and vineyards is not included in these factors

Table 6. Labor, machinery, improvement, and other costs by type-of-farming areas, 1939.

Type-of-Farming Areas	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,346	85	136	49	65	216	68	33	139	60	122	50	144	42	22	34	78
Man Labor.																	
Number of men	1 9	2 0	1 9	2 7	1 8	1 8	2 1	1 9	1 8	1 6	1 9	2 6	1 8	1 6	1 8	1 7	2 1
Man labor cost, total	\$ 985	\$1,085	\$1,553	\$1,018	\$1,018	\$ 970	\$1,113	\$ 979	\$ 958	\$ 758	\$ 965	\$1,406	\$ 841	\$ 733	\$ 824	\$ 801	\$ 881
Hired labor	242	329	258	794	217	191	286	151	211	88	210	725	198	109	198	132	77
Charge for family help	218	192	179	228	222	206	257	252	199	221	224	202	292	164	211	213	354
Charge for operator's labor	525	564	572	531	579	573	560	576	548	454	521	479	444	490	445	456	450
Man labor cost per tillable acre	9 10	8 14	6 94	22 16	10 80	7 79	9 36	6 79	8 79	8 95	9 32	15 56	8 38	8 30	7 18	11 65	15 12
Power and Machinery.																	
Machinery cost, Total	\$ 327	\$ 377	\$ 341	\$ 461	\$ 277	\$ 333	\$ 392	\$ 374	\$ 359	\$ 235	\$ 295	\$ 444	\$ 278	\$ 232	\$ 286	\$ 281	\$ 290
Per tillable acre	3 02	2 83	2 34	6 60	2 94	2 68	3 29	2 59	3 29	2 78	2 85	4 92	2 77	2 62	2 49	4 09	4 98
Per cent farms using tractors	66	79	61	69	62	70	66	79	83	38	53	88	50	50	55	74	81
Number of horses	2 6	2 8	3 2	2 0	2 7	3 0	3 1	3 0	2 5	2 6	2 6	1 6	2 4	2 2	2 6	1 9	1 3
Improvements.																	
Net annual cost, Total	\$ 136	\$ 171	\$ 180	\$ 135	\$ 143	\$ 167	\$ 154	\$ 142	\$ 153	\$ 89	\$ 131	\$ 121	\$ 90	\$ 81	\$ 85	\$ 96	\$ 84
Per tillable acre	1 26	1 28	1 24	1 93	1 52	1 34	1 29	98	1 40	1 05	1 27	1 34	90	91	74	1 40	1 44
Investment per annual unit	141	127	146	328	140	141	161	136	161	90	138	238	120	111	116	132	130
Feed bought per tillable acre	\$ 2 23	\$ 3 13	\$ 2 50	\$ 2 03	\$ 5 16	\$ 2 11	\$ 1 76	\$ 1 18	\$ 1 76	\$ 1 14	\$ 1 81	\$ 1 56	\$ 1 46	\$ 38	\$ 2 41	\$ 3 71	\$ 4 05
Crop expense per tillable acre	1 87	1 67	1 28	11 37	1 79	1 61	1 94	1 70	2 03	89	1 47	4 61	1 25	89	1 23	1 88	1 80
Taxes per tillable acre	59	83	74	1 18	74	69	76	58	75	60	68	81	50	39	51	71	57
Other expenses per tillable acre	76	79	72	1 22	1 01	69	1 17	65	77	53	76	64	53	56	51	1 29	1 04
Gross income per tillable acre	\$27 36	\$28 42	\$22 98	\$58 60	\$37 38	\$24 85	\$23 33	\$28 06	\$32 18	\$21 80	\$25 83	\$38 31	\$21 87	\$18 51	\$22 40	\$33 32	\$32 60
Total expenses per tillable acre	18 93	15 67	15 76	47 11	23 96	19 91	19 60	14 47	18 79	15 04	18 16	23 44	15 79	14 55	15 07	24 73	28 80
Net income per tillable acre	8 43	9 75	7 22	11 49	8 42	7 95	3 73	13 61	13 39	5 86	7 47	8 87	6 08	3 96	7 33	8 59	3 80
Expenses per \$100 income	69	66	69	80	74	68	84	52	58	73	70	77	72	79	67	74	88

FEEDING AND CONFINEMENT REARING EXPERIMENT WITH TURKEYS DURING 1939

F. N. BARRETT, C. G. CARD AND ASHLEY BERRIDGE
SECTION OF POULTRY HUSBANDRY AND LAKE CITY EXPERIMENT STATION

Two major problems confront the grower of market turkeys. Not only must the product be of choice quality to obtain the best possible selling price but the production costs must be kept as low as possible if the maximum profit is to be realized. It is evident that these two problems are influenced by several factors of which the feeding program plays a dominant role. Earlier trials resulted in the development of mashes which apparently are adequate for normal growth and the excellent development of turkeys reared under confinement conditions. The more recent work has been concerned with reducing feeding and rearing costs without limiting the finest development of the birds. In this latter connection, the grain studies started in 1938 immediately proved this to be a very promising field for exploration.

The result of free choice feeding of grains was rather startling as to the kind preferred and also as to the proportion of whole grain consumed. With the check mash 7, the grain part of the diet increased 65 per cent while the more expensive mash was reduced by a like amount and costs were materially reduced. The work with grains is being continued. This report is the fifth of a series of turkey production studies in which the rearing method of the manner of presenting data are comparable.

1939 Objectives

The 1939 trials include a continuation of studies with reference to the grain part of the diet and possible factors that might influence the proportion of grain to mash that the birds consume.

Little is really known as to which is the best grain for turkeys and whether only one grain or a combination of grains should be fed for the best and cheapest results. What is the effect of mashes of different protein levels on the proportion of grain consumed and the resulting cost? What might be revealed if the birds had a free choice of several grains? Is it possible that certain grains may be preferred during the growing period and others at the finish? The work with grains is an attempt to answer these and similar questions. Three pens of turkeys were used in the free-choice hopper feeding trials with corn, wheat, oats and barley as the grains. These four grains were fed in combination with our standard mash number 7 and also with a concentrate mash number 13. The birds were given full opportunity to express a possible preference for certain grains at the various stages of development. Costs and rearing studies with a small type Bronze turkey, and a cross of the small type and standard Bronze strains were included this year to understand better the economic characteristics

of these sorts. It has been a common practice in conducting feeding trials with turkeys to use a random selection of poults regardless of the sex ratio. Work was started this year with a separate pen of male and of female Bronze turkeys to observe possible differences in feed intake and cost per pound of gain for each sex.

Incubation and Starting Methods

The poults used in these trials were hatched at the poultry laboratory at East Lansing from eggs produced by the breeding flock of Bronze turkeys at the Lake City Experiment Station. The hatching date for the different pens is given in Table 1-A. The young poults were kept for the first 24 hours in baby chick boxes. At the end of that time they were placed under small brooders in the laboratory in lots of about 40 poults each. Mash in hoppers (together with water in vacuum fountains) was the only food given for the first week. Burlap was used for a floor covering for the first three or four days, after which time fine shavings were used until the birds were removed to Lake City.

Experimental Pens at East Lansing

At the end of the first week the poults were sorted into experimental lots of 25 each. Each lot was provided with an indoor pen $4\frac{1}{2}$ feet wide and 10 feet long with an electric hover. Perches were added when the hovers were no longer required.

It was necessary to remove the poults hatched on May 22 to quarters in a laying house, when they were three weeks of age, to give the preferred location in the laboratory to younger birds. The birds remained in these quarters until removed to Lake City at the end of the seventh week.

The poults of the second lot remained in the quarters first mentioned until the end of the sixth week. With each group it was necessary to keep the poults under the conditions described until their age and the weather condition made it possible to transfer them to the large, open turkey house at Lake City.

The Lake City Turkey House

At the Lake City Station, each lot of approximately 25 turkeys was confined to a pen 10 feet wide and 24 feet deep in the open-front turkey house. This building, which is 100 feet long, is constructed of rough lumber and poles. The house is divided into 10 pens with wire and wood partitions. At the end and back walls are hinged panels that may be opened for summer ventilation. At the rear of each pen are perches and a screened dropping board. The floors are of concrete, and straw was used for litter.

Feeding Plan

With the free-choice grain feeding trials, Pens 5, 8, and 9 were used as is shown in Table 1-A which outlines the feeding plan. Pen 8 received mash 7 for the entire period. The birds in Pens 5 and 9 received mash 7 until the end of the eighth week at which time they were changed to mash 13 until the completion of the trials. Mash 13 is a

Table 1. Rations.

Mash Number.	7	13
Protein Content of Mash (per cent)	27.2	31.0
	per cent	per cen
Ground yellow corn	10	6
Ground oats	15	15
Wheat bran	10	10
Wheat flour middlings	10	
Meat scrap	14	12
Fish meal		8.5
Dried skim milk	10	10
Soybean oil meal	22	25
Alfalfa meal	5	10
Calcium carbonate	1	2
Salt	1	1
*Cod liver oil	2	.5
Total.	100	100

*A Cod liver oil of 85 Vitamin D units was used in ration 7 while a "fortified" oil of approximately 400 units was used in ration 13. Cod liver oil was discontinued in all rations after the sixteenth week.

concentrate mash, with a protein content of 31 per cent, and mashes of this type are expected to bring about the consumption of relatively large amounts of grain. Corn, wheat, oats and barley were hopper-fed in an equal and free-choice manner to all three pens from the end of the eighth week until the end of the trials. These grains were available at all times for the birds in two, regular, turkey feeding hoppers, each of which was provided with a central partition to make four equal compartments. Each compartment was 8 inches wide and 2 feet long giving the birds an opportunity to eat from either side. Each week, at time of weighing, the grains were arranged in a new combination to eliminate the possibility of any advantage due to location. Pen 8 may be compared with Pen 2 which had mash 7 for the entire period but had corn as the only grain.

Table 1-A. Feeding plan.

Pen	Breeding	No. of Birds	Hatching Date	Mash	Grain	
1	Small Type	23	Apr. 10	7	Corn	
2	Bronze	25	May 22	7	Corn	
3	Bronze	25	May 22	7	Corn	
4	Bronze	25	May 22	7	Corn	
*5	Bronze	25	May 22	7 and 13 ..	Corn,	wheat, oats, barley
6	Cross-bred..	18	May 22	7	Corn	
†7-A	Small Type	12	May 22	7	Corn	
†7-B	Small Type	16	June 5	7	Corn	
8	Bronze	25	June 5	7	Corn,	wheat, oats, barley
*9	Bronze	25	June 5	7 and 13 ..	Corn,	wheat, oats, barley
10	Cross-bred..	30	June 5	7	Corn	

Mash was available at all times from the first day to the end of the trials.

Chopped, fresh alfalfa was given daily after the third week.

Grain and gravel were added to all diets at the end of the eighth week.

*Pens 5 and 9 received mash 7 until the end of the eighth week after which time both pens received mash 13 until the completion of the trials.

†Pen 7 was made up of birds of two ages because of the small number of poults available.

Pens 6 and 10 were composed of poults resulting from a cross-mating of a small type male and standard Bronze female.

The work with the small type Bronze strain included Pens 1 and 7. It was necessary to use birds of two ages in establishing Pen 7, because of the small number of poults available.

Pens 6 and 10 were used with the cross-bred birds resulting from a mating of small type Bronze males and Standard Bronze females. The management of the cross-bred, as well as the small type birds was the same as with Pen 2 in which Standard Bronze turkeys were used. Comparisons may therefore, be made between these pens in the tables which accompany this report.

A study of possible differences in the feed requirements and cost of gains between male and female turkeys was undertaken in a small way with Pens 3 and 4 which were started with 25 Bronze poults in each. At the end of the twelfth week the birds in both pens were sorted as to sex, with the 21 surviving males being continued as Pen 3 and the 27 females as Pen 4.

Results

Free Choice Feeding Increased Proportion of Grain Consumed—

The economy of any feeding system is strongly influenced by the proportion of the entire diet that is comprised of whole grain, as the price of grain is usually about half that of the mash. It is important to note in Table 2 that Pens 5, 8, and 9, which were provided with a free choice of corn, wheat, oats and barley, consumed a significantly greater proportion of grain to mash than those pens which received only corn as the grain part of the ration. These birds all ate grain more eagerly from the start to the finish than those receiving only corn. Consequently, there was a substantial reduction in production cost. These results coincide with those obtained in the 1938 trials. When mash 7 is used with corn as the only grain, turkeys consume approximately 70 per cent of mash and 30 per cent of grain, as an average of the entire period, for each pound of gain. When the same mash was used with the free choice of four grains, the grain consumption increased to 49.6 per cent in 1938 and reached the high point of 57.6 per cent in the 1939 trials. The two pens on the concentrate mash 13, with free

Table 2. Proportion of mash and grain consumed.*

(Total mash and grain consumed equals 100)

Pen	0-4 weeks		5-8 weeks		9-12 weeks		13-16 weeks		17-20 weeks		21-24 weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1	100	0.0	100	0.0	75.9	24.1	78.5	21.5	65.3	34.7	46.4	53.6
2	100	0.0	100	0.0	92.5	7.5	84.0	16.0	65.9	34.1	44.8	55.2
*3	100	0.0	100	0.0	94.1	5.9	84.4	15.6	65.9	34.1	45.5	54.5
*4	100	0.0	100	0.0	90.1	9.9	84.4	15.6	63.6	36.4	33.7	66.3
5	100	0.0	100	0.0	60.8	39.2	51.7	48.3	22.8	77.2	10.1	89.9
6	100	0.0	100	0.0	99.8	0.2	99.9	0.1	85.9	14.1	45.3	54.7
7	100	0.0	100	0.0	Not comparable							
8	100	0.0	100	0.0	77.4	22.6	48.8	51.2	20.5	79.5	12.2	87.8
9	100	0.0	100	0.0	64.9	45.1	39.6	60.4	22.3	77.7	14.1	85.9
10	100	0.0	100	0.0	86.0	14.0	86.6	13.4	56.4	43.6	30.2	69.8

*Mash in hoppers from the start. Grain hopper fed after the eighth week until the end of the period.

**At the end of 12th week, all of the birds in Pens 3 and 4 were separated as to sex. After this period Pen 3 was continued with the 21 males and Pen 4 with the 27 females resulting from this separation.

choice of grains, consumed an average of 51.2 per cent of their total feed in the form of grain in 1938. In repeating these trials with two pens in 1939, the average grain consumption, as based on the entire period, was 61.6 and 64.9 per cent, respectively. The quality of the finished turkeys was excellent and appeared to be equally as good as that of birds fed the more costly diet combinations. What is the reason for this increase in grain, especially, as may be noted with the 27-per cent protein mash? Is it due to the greater interest in grain because of the variety, or is it due to the unusual liking for oats, which turkeys consume in great quantities when they have the opportunity?

Turkeys Preferred Certain Grains—Of the grains fed, oats again ranked first with all three pens. As in the previous year, birds in all pens ate oats eagerly from the beginning to the end of the trials. Oats was the preferred grain at the finish with Pens 5 and 9 but was slightly exceeded by wheat during the last two weeks with Pen 8. In all pens, barley was eaten in large amounts during the first four weeks of the grain feeding, but interest in this grain dropped rather sharply after that time. Wheat, rather than corn, gained in preference at the finish, and the increase was confined largely to the last four weeks. Corn in 1939, ended in fourth position in all three trials. Pen 9 was the only pen that showed any interest in corn and then only in the last four weeks. Its corn total for 16 weeks was 130.5 pounds while oats totaled 799 pounds. Pen 5 consumed a total of only 7 pounds of corn for the entire 16 weeks in which grain was fed, but ate 557 pounds of oats during that time. Pen 8 ate only 2.5 pounds of corn while consuming 604 pounds of oats. Why are turkeys so consistent in their enthusiasm for oats? Is it a desire for more bulky foods or do oats contain some nutrient that is wanted in larger amounts than is otherwise provided? The percentage of the total grain consumption for each of the four grains used that year is as follows:

	Pen 5	Pen 8	Pen 9
	per cent	per cent	per cent
Corn.....	.6	.2	10.8
Wheat.....	18.6	26.9	11.5
Oats.....	53.2	59.4	66.3
Barley.....	27.6	13.5	11.4
Total.....	100	100	100

Male Turkeys Made Cheaper Gains than Females—With the separate pens of male and female turkeys, which were established with the birds in Pens 3 and 4 at the end of the twelfth week, the males made the more economical gain. During the last 12 weeks, the males ate an average of 4.93 pounds of feed while the females consumed 5.60 pounds for each pound of gain. The feed costs per pound of gain for the males during this period was \$0.096 as compared with \$0.108 for the females. The average of the combined pens for the entire 24-week period was \$0.89 per pound of gain. It is generally known that the later gains with turkeys are made less efficiently than those made earlier in the birds' development, and consequently are higher than the average of the entire growth period. These statistics are the re-

Table 3. Pounds of feed consumed per pound of gain.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash.....	3.12	3.07	3.01	3.01	1.76	4.04	2.95	2.08	1.61	2.78
Corn.....	1.38	1.30	1.37	1.37	trace	.93	1.77	trace	.32	1.56
Wheat.....					.53			.76	.34	
Oats.....					1.51			1.69	1.97	
Barley.....					.78			.38	.34	
Mash and Grain Total.....	4.50	4.37	4.38	4.38	4.58	4.97	4.72	4.91	4.58	4.34

sults of only one year, and no definite conclusions will be drawn until more trials have been made.

Feed Consumed per Pound of Gain—The average amount of mash and grain required to produce a pound of gain is given in Table 3. It is of interest to note the relatively low mash consumption of those pens having a free choice of grains. Inasmuch as Pens 3 and 4 were separated as to sex and reestablished at the end of the twelfth week, the figure presented for them in both instances, is the combined average.

Average Cost of Producing a Pound of Gain—In determining the merit of any ration, the cost of producing a unit of gain is one of the factors to be considered. This information is given for each pen in Table 4. Consideration should also be given to the normal development of the birds, the growth rate, the character of the finished product, and any other advantage or disadvantage of a particular ration before definite conclusions are drawn. The 1939 feed costs were slightly higher than those of 1938 owing to an advance in price of most of the feed materials used.

1939 Feed Prices—The average prices paid for the different mashes and grains are shown in Table 5. Mash prices advanced 17 per cent in 1939 over those of 1938. With the grains, wheat advanced 41 per cent, oats 60 per cent, barley declined 20 per cent, while the price of corn remained the same as in the previous year.

Table 4. Feed cost per pound of gain.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash.....	\$.073	\$.072	\$.071	\$.071	\$.044	\$.095	\$.069	\$.049	\$.041	\$.065
Corn.....	.018	.017	.018	.018	.....	.012	.024	.....	.004	.021
Wheat.....					.008			.012	.005	
Oats.....					.015			.017	.020	
Barley.....					.009			.004	.004	
Mash and Grain Total.....	\$.091	\$.089	\$.089	\$.089	\$.076	\$.107	\$.093	\$.082	\$.074	\$.086

Table 5. Feed price per 100 pounds.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash 7.....	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35	\$2.35
Mash 13.....					2.60				2.60	
Corn.....	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
Wheat.....					1.55			1.55	1.55	
Oats.....					1.00			1.00	1.00	
Barley.....					1.10			1.10	1.10	

Growth Rates—The rate of growth of the different groups may be noted from the data presented in Table 6 which gives the average weights of both male and female turkeys at the end of each four-week period.

Mortality—Of 247 poults that started the trials, all but 18 completed the 24 weeks in good marketable condition. Those not finishing included two birds that had broken legs, two others which died from accidental causes, one male removed because of fighting and three birds removed because of pendulous crops. Mortality, perosis, and crooked breast bones have not been serious problems with the birds in recent years.

Final Weights—The final weights of both male and female turkeys are given in Table 7. There was very little observable difference in the quality of the birds at the finish and there were very few that would not be classified as Grade 1.

Summary

The feeding of corn, wheat, oats and barley to turkeys on a free-choice basis consistently increased the total amount of grain consumed and the proportion of grain to mash.

When these four grains were presented in an equal and free-choice manner, the birds consumed more pounds of oats than any other single grain.

Table 6. Growth of turkeys.

(Average weight in pounds)

Pen	4 weeks		8 weeks		12 weeks		16 weeks		20 weeks		24 weeks	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1.....	.88	.81	2.74	2.36	5.53	4.53	8.80	6.74	11.93	8.39	14.53	9.63
2.....	.94	.86	3.24	2.77	6.28	5.09	10.54	8.04	15.15	10.72	19.31	13.02
3.....	.97	.86	3.23	2.74	6.71	5.41	11.09	8.44	15.86	11.24	20.23	13.50
4.....	.99	.85	3.07	2.64	6.36	5.26	10.26	8.26	14.81	10.95	18.97	13.17
5.....	.95	.91	3.07	2.77	6.75	5.69	10.77	8.65	15.40	11.69	19.63	13.88
6.....	.83	.64	2.85	2.12	6.01	4.48	9.80	7.02	13.89	9.26	17.08	11.18
7.....	.74	.62	2.60	2.08	5.45	4.22	9.00	6.55	13.04	8.71	16.49	10.41
8.....	.96	.81	3.03	2.46	6.71	5.15	11.24	8.18	16.36	11.33	20.44	13.35
9.....	.91	.86	2.92	2.50	6.12	5.21	10.55	8.39	15.46	11.33	19.45	13.63
10.....	.99	.90	3.05	2.67	6.65	5.42	10.66	8.25	15.11	11.03	18.41	13.01

Table 7. Final weights of turkeys in pounds at 24 weeks of age.

	Pen									
	1	2	3	4	5	6	7	8	9	10
Birds Started.....	23	25	25	25	25	16	28	25	25	30
Surviving Birds.....	22	24	23	24	22	13	25	22	25	29
Total Weights.....	265.7	394.2	357.6	397.3	368.6	192.5	339.3	357.5	404.8	458.3
Number of Males.....	11	13	7	14	11	8	13	9	11	15
Heaviest Male.....	17.0	22.8	21.6	20.3	22.3	18.9	18.8	22.6	20.6	20.9
Lightest Male.....	13.2	15.3	18.5	17.0	16.6	13.0	15.3	18.8	17.0	15.6
Average Weight....	14.53	19.31	20.23	18.97	19.63	17.08	16.49	20.44	19.45	18.41
Number of Females.....	11	11	16	10	11	5	12	13	14	14
Heaviest Female.....	12.1	16.6	15.8	15.4	16.0	11.9	11.7	14.8	15.0	14.3
Lightest Female.....	8.1	9.8	11.8	11.8	13.0	10.5	9.5	11.0	12.2	11.8
Average Weight....	9.63	13.02	13.50	13.17	13.88	11.18	10.41	13.35	13.63	13.01

Oats again ranked first in total pounds consumed and were eaten eagerly by the birds from the start of the feeding trials to the finish. During the 1939 trials the birds consumed more pounds of oats than all other grains combined.

Wheat was generally preferred to corn and was eaten most eagerly during the last four weeks of the trials.

Barley was eaten in rather large amounts during the first four weeks of the grain feeding, but the interest in this grain dropped rather sharply after that time.

Corn was the grain least preferred in 1939 with all pens. Only one pen showed any interest in this grain and then only in the finishing weeks.

The work with grains strongly suggests a possible advantage of including hoppers of whole oats along with corn, or even with wheat if the price permits, throughout the grain feeding period.

The concentrate mash 13, continues to give highly satisfactory results in the manner used.

Male turkeys made more efficient use of feed than did females, from the twelfth week to the finish, and produced gains at slightly lower cost.

Several years of rearing turkeys under confinement conditions have clearly demonstrated the feasibility of such a system for the rearing of market turkeys.

THE REDHAVEN PEACH

STANLEY JOHNSTON
SECTION OF HORTICULTURE

For many years the Elberta peach so completely dominated the peach variety list and comprised such a high proportion of the trees in orchards in virtually every peach growing state, that well distributed and orderly marketing of peaches was practically impossible. There usually would be a scarcity of peaches during the early part of the season and an oversupply during the Elberta harvest.

This condition was brought about largely because of the lack of varieties maturing earlier than Elberta which had good handling and shipping qualities. In an effort to assist in correcting this condition a peach breeding experiment was started by the Michigan Agricultural Experiment Station at its South Haven Station in 1924. The first practical result of this project was the introduction of the Halehaven peach in 1932, and next, the introduction of Kalhaven in 1936. Kalhaven matures about four days before Elberta, Halehaven about 17 days, and now, as a third step in the program, the introduction of the Redhaven peach is announced— a variety maturing about 30 days earlier than Elberta.

Redhaven originated at the South Haven Experiment Station from a cross made between Halehaven and Kalhaven (Halehaven x Kalhaven) in 1930. At that time, neither parent had been named but were still under trial and known only by number.

Trees of the Redhaven variety have shown no weaknesses to date and are vigorous and very productive. The scaffold branches usually originate at wide angles with the trunk which add to their strength. Fruit buds are apparently much hardier than those of Elberta but not so hardy as those of such varieties as South Haven and Rochester.

The blossoms are comparatively small, orange-pink in color, with the stamens and pistil protruding beyond the petals in the unopened flower. An abundance of pollen is produced and the variety is self-fertile, having an inclination to set fruit heavily.

The fruits of Redhaven mature very early, about a month before Elberta. They are medium in size, slightly elongated in shape, and usually almost completely covered with a brilliant red color. Where the ground color shows it is a bright yellow. The skin is smooth and tough. The flesh is yellow, firm, fine-textured, moderately sweet in flavor and of good quality. Fruits of this variety make a fine appear-

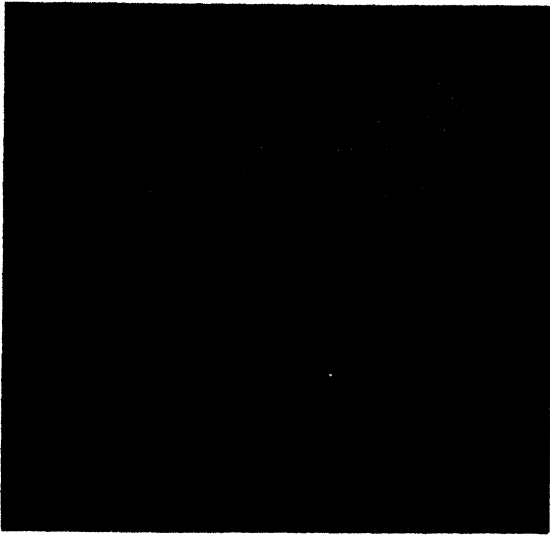


Fig. 1. The Redhaven peach in natural color and size.

ance when sliced and served fresh. Apparently the stone is always free. The firm flesh and tough skin indicate considerably better handling qualities than are usually found in a peach of this season.

In general, it is believed that this variety has the necessary qualifications of an excellent early maturing peach. The one step in its culture that will demand close attention for best results will be proper thinning. If the fruits are properly thinned there should be no difficulty in obtaining peaches of A-grade size.

It is a good rule to test all new fruit varieties in moderate numbers before making extensive plantings. Redhaven is no exception to this rule. The grower should also consider the season of this variety carefully in relation to his location and market demands for such an early variety. For many growers, a variety of this season with good handling qualities will fill a long felt need. For others, it may mature at a season when competition from peaches shipped in from other sections is such that there would be serious doubts as to how many early-maturing, locally-grown, peaches could be disposed of to advantage.

SNOW DAMAGE TO CONIFER PLANTATIONS

MAURICE W. DAY
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The winter of 1938-1939 was one of unusually heavy snowfall in the Upper Peninsula of Michigan. The U. S. Weather Bureau station at Sault Ste. Marie recorded a total snowfall of 128 inches. This heavy snowfall furnished an excellent opportunity to study the damage caused by snow in young coniferous plantations.

The plantations studied were those on the Dunbar Forest Experiment Station. These plantations are made up of blocks of red pine, white pine, Scots pine, Norway spruce, and white spruce; their age varies from 10 to 13 years from the time of planting.

Each plantation was examined separately, and the individual trees examined in each plantation were mechanically selected over the entire plantation. The number of trees examined was determined by the size of the plantation; the trees are listed by species in Table 1.

The damage consisted almost entirely of a breaking away of the lower lateral branches that were below the snow level. The degree of damage was determined for each tree. Trees having three or more branches broken away were classified as having suffered severe damage, because those trees were usually weakened seriously. The branches are usually not broken completely away from the main stem of the tree, but remain attached to the trunk. This condition probably will cause defects in the lumber eventually produced by those trees, most typical of which will be small loose knots. Because of the large amount of resin exuded by these wounds, the amount of fungous infection will probably be small.

The amount of damage to the several species is shown in Table 1. Red pine was most heavily damaged with 17.9 per cent; the next being white pine, 7.3 per cent; white spruce, 2.0 per cent; Norway spruce, 1.2 per cent; and Scots pine, 0.9 per cent. All percentages are based

Table 1.

Species	Degree of Snow Damage						Total number of trees examined	Total per cent of trees damaged
	None		Moderate		Severe			
	Number of trees	Per cent of total	Number of trees	Per cent of total	Number of trees	Per cent of total		
Red Pine	879	82.07	140	12.81	56	5.12	1,093	17.93
White Pine	506	92.68	33	6.04	7	1.28	546	7.32
White Spruce	247	98.01	4	1.50	1	0.40	252	1.00
Norway Spruce	323	98.77	3	0.92	1	0.31	327	1.23
Scots Pine	210	99.06	2	0.94	0	0	212	0.94

upon the total for that species. The amount of severe damage was roughly in proportion to the total damage.

The relationship of height to damage was studied. It was found that the damaged trees were largely the smaller trees of the stands, especially when these were surrounded by larger trees. Average heights of undamaged and damaged trees are given for the various species in Table 2.

Table 2.

Species	Average Height All Trees	Average Height of Damaged Trees		
		Moderate Damage	Severe Damage	All Damaged Trees
Red Pine.....	7.74	5.40	4.57	5.16
White Pine.....	7.39	5.82	5.00	5.65
White Spruce.....	4.60	4.50	5.00	4.60
Norway Spruce.....	3.45	2.33	1.00	2.00
Scots Pine.....	11.27	7.50	—	7.50

A one-fourth acre plot of red pine, containing 175 trees averaging 7.8 feet in height, was pruned in the fall of 1938. The trees were pruned so as to leave at least four whorls of branches; this amounted to pruning to about an average height of 4½ feet from the ground. No trees were damaged in this plot, thereby indicating that early pruning will prevent this type of snow damage.

The breaking of branches is usually confined to the late winter or early spring when the snow is melting. The branches buried in the snow are slowly pulled downward as the snow melts and settles; when the strain becomes sufficiently strong the branch tears away from the trunk or pulls out of the snow. Snow with an ice crust is more likely to damage the tree.

The practical application of this study lies mainly in the selection of species most suitable for planting in areas likely to be most subject to snow damage. The results of this study may also be applied to farm windbreak and snowfence plantings. Of the species studied, Scots pine and the spruces seem best adapted to deep snow conditions. Where red pine and white pine are planted, damage may be greatly reduced by pruning to a height of three or four feet at as early an age as possible. Since damage is less after a height of 8 to 10 feet is reached, measures to obtain thrifty growth are advantageous.

TRACTOR COSTS IN MICHIGAN, 1939

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Fifty-six farmers in Michigan, operating 60 tractors, cooperated with the Farm Management Department in a study of tractor costs in 1939. The records kept by these men included cash operating expenses, as well as the fixed charges for depreciation, interest, and shelter on their individual tractors. The men kept a record of the hours used for all operations, including belt, drawbar, and custom work. As well as keeping the tractor record, these men also were cooperators in the Farm Accounting Project of the Farm Management Department. It was, therefore, possible to get information on the acreage and production of the various crops, the number and production of the various kinds of livestock, and the receipts and expenses of operating each co-operator's farm.

The 60 tractors used in this study were located on farms throughout Michigan, but primarily in the southern part of the Lower Peninsula, where general farming is the most prevalent. There were 25 one-plow, 30 two-plow, and 5 three-plow tractors included in this study. All but 2 of the one-plow tractors were of the general-purpose type, and these 2 were orchard type tractors. Twenty-two of the two-plow tractors were of the general-purpose type, while 3 of the three-plow tractors were of the standard type and 2 were of the general-purpose type.

The average cost per hour of operating the various types and sizes of tractors is shown in Table 1. Fuel and lubricants were charged at each individual farmer's purchase price. Man labor used in servicing and repairing the tractors was charged at 25 cents an hour unless otherwise specified by the operator. Figures for annual depreciation and value of the tractor were furnished by the operator and interest was charged at 6 per cent on the average value of the tractor in 1939.

One-Plow Tractor Costs

About 42 per cent of the tractors in this study were of a size which, for lack of a better term, have been designated as the one-plow size. This percentage of the total group of tractors in the study compares with 33 per cent in 1938 and 21 per cent in 1937. Assuming this sample is representative, this indicates a definite increase in the proportion of small tractors on Michigan farms. The 25 one-plow tractors in the study this year averaged slightly more than two years old at the beginning of 1939, and were worth an average of \$565 each (Table 1).

*K. T. Wright and E. B. Hill, both of the Farm Management Department, inaugurated this study in 1933 and have assisted by giving many valuable suggestions. Members of the extension service of the department were in charge of collecting the tractor records.

Table 1. Relation of size and type of tractors to their yearly and hourly costs in Michigan, 1939.

Item	Size and type of tractor			
	1-Plow General Purpose*	2-Plow		3-Plow Both**
		General Purpose	Standard	
Number of tractors.....	25	22	8	5
Tractor age (years).....	2.1	2.0	10.5	1.4
Tractor value.....	\$565	\$804	\$251	\$1,067
Hours of use in year:				
Drawbar.....	395	508	183	430
Belt.....	32	65	16	77
Total (own and custom).....	427	573	199	507
Custom.....	31	55	7	86
Yearly costs:				
Operating expenses—				
Fuel.....	\$ 58	\$100	\$ 35	\$ 97
Lubricants.....	10	14	10	12
Repairs.....	9	14	12	9
Labor (chores and repairs).....	6	7	4	8
Auto use.....	1	1	0	2
Total.....	\$ 84	\$136	\$ 61	\$ 128
Fixed charges—				
Depreciation.....	65	103	34	108
Interest.....	32	44	15	59
Shelter.....	6	6	7	6
Total.....	\$103	\$153	\$ 56	\$ 173
Total yearly costs.....	187	289	117	301
Hourly costs:				
Operating.....	.20	.24	.31	.25
Fixed.....	.24	.27	.28	.34
1939 average hourly costs, total.....	\$0.44	\$0.51	\$0.59	\$ 0.59
1938 average hourly costs.....	.53	.57	.55	.56
1937 average hourly costs.....	.42	.58	.57	.52
1936 average hourly costs.....	.40	.63	.56	.68
1935 average hourly costs.....	.59	.58	.55	.63
1935-39 average hourly costs.....	.48	.57	.56	.60
Fuel for 10 hours (gal.) 1939.....	12.2	16.7	17.4	20.1
Oil for 10 hours (qt.) 1939.....	1.2	1.1	2.2	1.3

*Two of these were orchard type tractors.

**This group includes two general-purpose tractors and three standard tractors.

They were used primarily for drawbar work because only 32 of the 427 hours of use in the year were for belt work. Each tractor did about as many hours of custom work as it did belt work during the year. The cash operating expenses on these tractors totaled \$84 for the year, and the fixed charges amounted to \$103. The total yearly cost of operating these small tractors was, therefore, \$187 or about 44 cents an hour. Of the total costs 45 per cent were cash expenses and 55 per cent were fixed charges. This hourly cost was about 9 cents less than for 1938 when these tractors were used about the same number of hours but with more fuel and higher depreciation charges. This figure was also 4 cents an hour less than the 1935-39 average.

Two-Plow Tractor Costs

The 30 two-plow tractors in this study were divided into two groups—22 general-purpose and 8 standard tractors. The general-purpose tractors averaged about 2 years old and were used about 34 per cent more than the one-plow size and, incidentally, more than any other size group in the study. The yearly cost for 573 hours of use was \$289, 47 per cent for cash operating expenses and 53 per cent for fixed charges. The total charges amounted to 51 cents an hour which is 6 cents less than the charge for either 1938 or for the 5-year average 1935-39.

The standard type two-plow tractors are evidently on their way out of Michigan's agriculture. There has been a smaller percentage of these tractors each succeeding year of this study and they have been the oldest of all the groups. In 1936 there were 22 of this type tractor in the study; in 1937 there were 17; in 1938 there were 12; and in 1939 there were only 8. These 8 tractors averaged 10.5 years old and were only used an average of 199 hours during the year at a cost of about

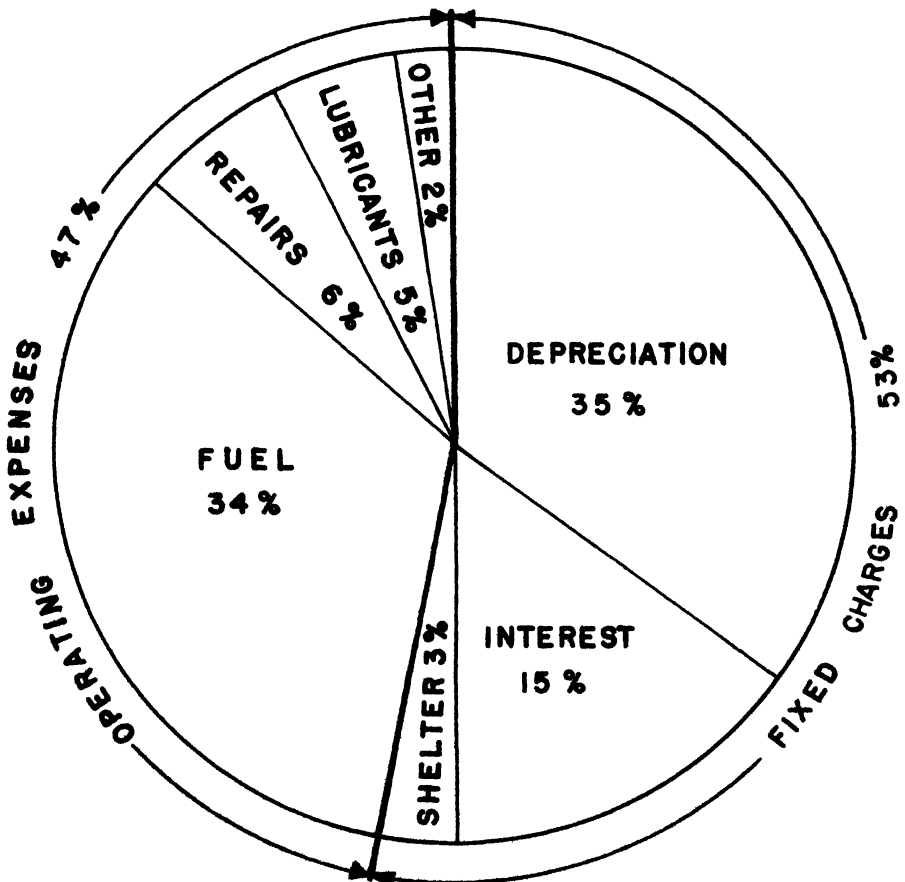


Fig. 1. Percentage distribution of cost items on two-plow tractors, 1939.

\$117 or 59 cents an hour. The average value of these tractors was only \$251, making depreciation and interest charges relatively low. Cash operating expenses amounted to 52 per cent and fixed charges were 48 per cent of the annual charges.

Figure 1 shows that 53 per cent of the annual costs on all of the two-plow tractors were fixed charges while 47 per cent were for cash operating expenses. Depreciation and interest were the major fixed charges, and fuel was the largest item of the cash operating expense.

Three-Plow Tractor Costs

Records were kept on only 5 three-plow tractors in 1939. Two of these were general-purpose tractors and 3 were standard. These 5 tractors averaged 1.4 years old at the beginning of 1939, were valued at \$1,067 and were used an average of 507 hours, 86 of which were on custom work. These three-plow tractors were used on belt work 15 per cent of the time which is more than any other size group. Cash operating expenses amounted to \$128 a tractor, and fixed charges \$174. The high fixed charge was caused by the relatively new, high valued tractors. The hourly expenses amounted to 59 cents, 42 per cent for operating expenses and 58 per cent for fixed charges.

Kinds and Amounts of Fuel Used

The amount of fuel used averaged 1.2 gallons per hour for the one-plow tractors, 1.7 for the two-plow tractors and 2.0 gallons for the three-plow tractors (Table 1). Table 2 shows that about three-fourths of the fuel used in the tractors in this study was gasoline and about one-fourth fuel oil. Kerosene was used very little in the one-plow tractors and none in the other sizes.

Table 2. Proportion of various kinds of fuels used in different sized tractors in Michigan, 1939.

Item]	Percentage of each kind of fuel used in various sized tractors		
	1-Plow	2-Plow	3-Plow
Gasoline.....	76	71	79
Fuel oil.....	23	29	21
Kerosene.....	1	0	0

Tractor Use by Operations

The one-plow tractors in this study were used 93 per cent of the time for drawbar use, which consisted primarily of plowing and the operations carried on in seedbed preparation, in addition to many miscellaneous uses (Fig. 2). The latter was made up of several different items the most important of which were hauling manure, grain, and feed.

About 89 per cent of the two-plow tractor work was on drawbar, with plowing and dragging the most important single operations. Miscellaneous work done by the two-plow tractors was similar to that

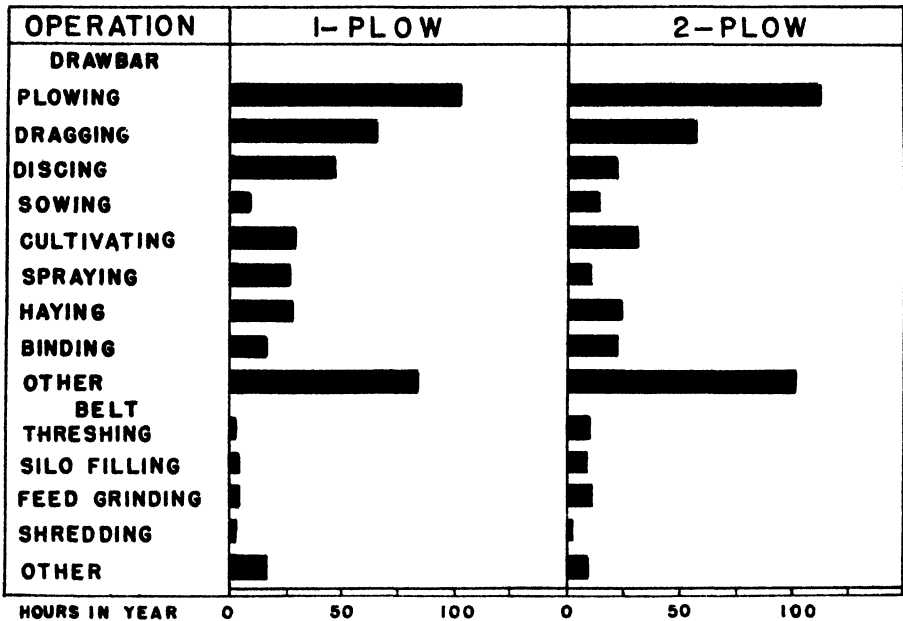


Fig. 2. Hours of tractor use by operations for one- and two-pow tractors, 1939

done by the one-pow tractors with the addition of some operations such as cutting corn and combining. The belt work was divided between four specific jobs and a group of miscellaneous jobs, but belt work, as a whole, did not take a very large portion of the time of these one- and two-pow tractors.

The three-pow tractors were not shown in Figure 2 because of an insufficient amount of information. These large tractors were used for belt jobs 15 per cent of the time which was more than for the other sizes. (See Table 1).

Hours of Tractor Use and Tractor Costs

Tractor use on these farms ranged from 97 to 1,033 hours per tractor. The number of hours that a tractor is used during a year has a direct influence on the total tractor cost and upon the cost per hour of use. Eight of the two-pow tractors were used less than 250 hours, averaging only 149. The total cost for the year for this group was \$95 a tractor, or 63 cents an hour (Table 3). Tractors in this group had a high hourly cost, which would have been still higher had the tractors not been so old, and low-valued, making the fixed charges low.

Eleven of the two-pow tractors were used more than 550 hours, averaging 757 hours for the year, or more than four times as much as were those tractors in the low-use group. The total tractor cost was \$353, or an hourly cost of only 47 cents as compared to 63 cents for the low-use group. Increased tractor use makes for increased total costs, but decreased hourly costs.

The tractors were used much more for custom work in the high-use

Table 3. Influence of hours of use on two-plow tractor costs in Michigan, 1939.

Item	Hours use in year		
	0-250	251-550	551-up
Number of tractors	8	11	11
Tractor value (beginning of year)	\$ 228	\$ 804	\$ 896
Tractor age (average years)	10.0	2.1	1.4
Hours of use in year:			
Drawbar	137	388	661
Belt	12	38	96
Total	149	426	757
Custom	5	13	92
Yearly costs:			
Operating	\$ 50	\$ 105	\$ 175
Fixed	45	136	178
Total	\$ 95	\$ 241	\$ 353
Net cost to own farm	91	223	247
Hourly costs:			
Operating . . . . .	.33	.25	.23
Fixed . . . . .	.30	.32	.24
Total	\$0.63	\$0.57	\$0.47

group than in the low-use group. On the low-use group the income from the tractor's share of the custom work reduced the total tractor cost \$4, and \$106 on the high-use group. This reduced the cost per hour of work on the operator's own farm a negligible amount on the low-use group, but nearly 10 cents an hour on the high-use group which did much more custom work than the other groups. It is clear that some farmers can do custom work to reduce their own net tractor costs, but they must be careful not to lower the income on their own farms while doing it.

Influence of Size of Farm.

The farms on which these tractor records were kept were divided into three groups according to the size of the farm. The 16 small farms averaged 76 acres, the 22 medium-sized farms 136 acres, and the 17 large farms 274 acres (Table 4). These groups of farms had 71, 62, and 59 per cent, respectively, of their land area in crops. The three groups had about equal amounts of livestock per crop acre.*

The tractors on the small farms were used an average of 415 hours during the year with belt work comprising only 7 per cent of that amount, while the tractors on the large farms were used 581 hours with 15 per cent of that amount being belt work. The large farms had 200 per cent more crop acres than the small farms and 71 per cent larger businesses, but only 125 per cent more horses per farm, 33 per cent more men and 40 per cent more hours of tractor use. The use of a tractor on a large, extensive farm increases labor efficiency more than on a small, intensive farm, because the labor on extensive crops can,

*Crop acres are those from which crops were harvested in 1939, plus land in new seedings, summer fallow, and green manure crops.

Table 4. Relation of size of farm to labor and power costs on Michigan farms, 1939.

Item	Size of farm		
	Less than 100 acres	100-179 acres	180 acres and more
Number of farms	16	22	17
Farm organization:			
Acres in farm	76	136	274
Crop acres per farm	54	85	162
Productive animal units	12.2	18.7	34.9
Number of men	1.8	1.8	2.4
Number of horses	1.2	1.6	2.7
Days productive work, total*	367	406	629
—per crop acre	6.6	4.6	3.8
—per man	229	231	265
Total hours tractor use per farm	415	370	581
Total yearly tractor cost	\$ 188	\$ 181	\$ 290
Labor and power costs:			
Man labor (own, family, hired)	948	985	1,246
Horse work (\$75 per horse)	90	120	202
Net tractor cost (custom income deducted)	145	164	225
Total cost per farm	\$1,183	\$1,269	\$1,673
Cost per crop acre	21 91	14 92	10 33
Cost per day productive work*	2 87	3 03	2 62

*These data were not available for a few farms.

by introduction of a tractor, be reduced more than on intensive crops and livestock.

The charge for man labor, including an allowance for the operator and his family, as well as cash paid hired help, was the major item in the total labor and power cost, comprising 80 per cent of the total on the small farms and 74 per cent on the large farms. The labor charge per crop acre was about \$18 on the small farms and about \$8, or over 56 per cent less, on the large farms. The total labor and power cost per crop acre was \$21.91 on the small farms and only \$10.33, or nearly 53 per cent less on the group of large farms.

The comparison of total costs per crop acre is not fair unless the intensity of operations is considered. This was determined by computing the cost for each day of productive work. This showed that labor and power costs amounted to \$2.87 per day of productive work on the small farms, \$3.03 on the medium-sized group of farms, and \$2.62 on the large farms. The cost of power on these large farms was not less but the man labor was more efficient than on the small farms.

LEGUME SILAGE VS. CORN SILAGE VS. LEGUME HAY FOR FATTENING HEIFER CALVES

G. A. BRANAMAN AND G. K. DAVIS
SECTIONS OF ANIMAL HUSBANDRY AND AGRICULTURAL CHEMISTRY

The data presented here are the results of the second experiment in comparing the above-mentioned feeds. The first experiment was reported in the Quarterly Bulletin for August 1939. The results were relatively more favorable for legume silage in the first test than in the second. In the first test, it was necessary to add a protein-rich feed to the legume hay and corn ration in order for the cattle to maintain gains. Yearling steers were fed in the first test, while heifer calves were fed in this test.

In the second test, the cattle continued to make satisfactory gains, and no protein supplement was added to the ration. The hay used in the second test was considered to be of better quality than that used in the first test.

Objects of the experiment:

1. To compare alfalfa hay and alfalfa silage when equal amounts of corn are fed.
2. To determine the amount of corn required with alfalfa hay or alfalfa silage to equal well-eared corn silage.

Colorado-bred Hereford heifer calves of "good" grade were purchased on the Chicago market Nov. 2, 1939 at 9 cents per pound. They gained 15 pounds per head above Chicago weights in two weeks on oats, silage and hay, despite their having severe colds.

Alfalfa hay and silage were made from first-cutting alfalfa containing a heavy timothy mixture. Alternate swaths from the same field were ensiled immediately after mowing and 60 pounds of beet molasses were mixed with each ton of alfalfa. When properly cured, the hay in the remaining swaths was baled from the windrow with a pick-up baler. It kept very well with leaves well-conserved, although some discoloration resulted inasmuch as it was classified as No. 3 market grade.

Well-matured and well-eared corn silage was made from a field yielding 6.24 tons per acre, and shelling at that time 36.4 bushels per acre when dried to 15 per cent moisture, or 5.83 bushels per ton of silage, or 16.34 pounds per hundred pounds of silage.

Chemical analyses of the feeds being compared are shown in Table 1. Corn silage was somewhat higher in dry matter than was alfalfa silage, while dry matter content of the hay was approximately three times as high as that in the alfalfa silage.

In order to compare the feeds more easily and on a similar basis, the nutrient content was calculated on a water-free basis (recorded

Table 1. Chemical analyses of feeds.

	Dry Matter	Crude Protein	Ether Extract	Carbohydrates		Ash
				Crude Fiber	N-free Extract	
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Alfalfa hay.....	87.22	13.01	2.01	30.84	35.78	5.58
Alfalfa silage.....	29.29	4.39	1.51	9.33	11.83	2.23
Corn silage.....	33.72	3.27	1.37	6.71	20.61	1.76

in Table 2). Alfalfa hay and alfalfa silage are seen to be very similar when all the water has been removed. The silage was higher in ether extract and in ash, while the hay was higher in fiber content. Corn silage was lower than alfalfa silage or hay in all nutrients, except nitrogen-free extract and in the hay, ether extract. In nitrogen-free extract, which is the more soluble and digestible part of carbohydrate materials, corn silage was approximately 50 per cent higher than the other feeds.

Greater energy value, or fattening ability would be expected from the analysis of corn silage, while its low protein content would indicate a need for that nutrient.

Table 2. Analyses on water-free basis.

	Crude Protein	Ether Extract	Carbohydrates		Ash
			Crude Fiber	N-free Extract	
	Per cent	Per cent	Per cent	Per cent	Per cent
Alfalfa hay.....	14.01	2.30	35.35	41.05	6.39
Alfalfa silage.....	14.98	5.15	31.85	40.41	7.61
Corn silage.....	9.69	4.06	19.89	61.15	5.21

Rations Fed and Gains Made

Calves were weighed weekly and enough shelled corn was fed with free-choice hay allowance in Lot 1 to produce a gain in weight similar to that made by calves in Lot 2.

The Lot 2 calves were full-fed on corn silage twice daily, with one pound of cottonseed meal for each 400 pounds of calf weight, and hay was available in the rack.

Lot 3 calves were full-fed alfalfa silage twice daily and the same amount of corn as in Lot 1.

Salt and bonemeal were supplied in separate boxes to each lot.

After 111 days of feeding, during which time calves in all lots made very nearly the same gains, additional corn in equal quantity per calf was given to all lots. One heifer in Lot 3 went off feed completely just at that time and was removed. Her gain, which had been slightly below the lot average previously, was included, as well as feed consumption up to that time.

Table 3. Weights and gains of cattle and feed requirements.

	Lot 1	Lot 2	Lot 3
	Alfalfa Hay	Corn Silage	Alfalfa Silage
Nov. 17, 1939-JUNE 7, 1940 (202 days)			
Calves per lot.....	11	11	10*
Average initial weight.....	373.5	379.3	385.4*
FIRST PERIOD—Nov. 17, to Mar. 8:			
Gain per calf—111 days.....	178.5	182.6	167.9
Average daily gain—111 days.....	1.61	1.65	1.51
Average daily ration—111 days:			
Shelled corn.....	6.		6.
Cottonseed meal.....		1.1	
Alfalfa hay.....	8.2	1.8	
Alfalfa silage.....			19.9
Corn silage.....		22.3	
Feed for 100 pounds gain:			
Shelled corn.....	376.		399.
Cottonseed meal.....		68.	
Alfalfa hay.....	513.	109.	
Alfalfa silage.....			1316
Corn silage.....		1358.	
Feed cost for 100 pounds gain (low-priced feeds)**.....	\$ 5.81	\$ 4.24	\$ 5.75
LAST PERIOD—MAR. 8 to JUNE 7:			
Gain per calf—last 91 days.....	184.7	192.5	204.6
Average daily gain—last 91 days.....	2.0	2.1	2.25
Average daily ration—last 91 days:			
Shelled corn.....	10.8	4.9	11.3
Cottonseed meal.....		1.6	
Alfalfa hay.....	8.4	1.9	
Alfalfa silage.....			23.6
Corn silage.....		20.2	
Feed for 100 pounds gain:			
Shelled corn.....	530.	230.	502.
Cottonseed meal.....		76.	
Alfalfa hay.....	415.	91.	
Alfalfa silage.....			1048.
Corn silage.....		954	
Feed cost for 100 pounds gain (low-priced feeds)**.....	\$ 6.96	\$ 5.79	\$ 6.42
ENTIRE FEEDING PERIOD—Nov. 17 to JUNE 6:			
Final feed-lot weight.....	736.7	754.4	757.9
Gain per calf—202 days.....	363.2	375.1	372.5
Average daily gain—202 days.....	1.80	1.86	1.83
Average daily ration—202 days:			
Shelled corn.....	8.2	2.2	8.3
Cottonseed meal.....		1.3	
Alfalfa hay.....	8.3	1.8	
Alfalfa silage.....			21.6
Corn silage.....		21.4	
Feed for 100 pounds gain:			
Shelled corn.....	454.	118.	453.
Cottonseed meal.....		72.	
Alfalfa hay.....	463.	100.	
Alfalfa silage.....			1175.
Corn silage.....		1151.	
Feed cost for 100 pounds gain:			
**Low-priced feed.....	\$ 6.40	\$ 5.03	\$ 6.12
**Higher-priced feeds.....	7.99	6.29	7.64

*One calf was removed from Lot 3, March 8.

Gain and feed for first period were computed on basis of 11 calves.

**Feed prices: Low-priced feeds: Shelled corn—56c per bu.; cottonseed meal—\$32; alfalfa hay—\$8; alfalfa silage—\$2.67; and corn silage—\$4 per ton.

HIGHER-PRICED FEEDS: Shelled corn—70c per bu.; cottonseed meal—\$40; alfalfa hay—\$10; alfalfa silage—\$3.33; and corn silage—\$5 per ton.

Six pounds of corn and 8.2 pounds of hay daily in Lot 1 during the first period produced a gain similar to that produced in Lot 2 by 22.3 pounds of corn silage, 1.1 pounds of cottonseed meal, and 1.8 pounds of alfalfa hay. Calves in Lot 3 tended to lag slightly behind those in the other lots in gain when eating 6 pounds of corn and 19.9 pounds of alfalfa silage.

During the last 91 days of the test, with additional corn allowance, the alfalfa silage-fed calves in Lot 3 forged ahead in gain. The hay-fed calves in Lot 1 went off feed during the last two weeks, the gains dropping and costs rising; however, they were on full-feed again at the time of taking final weights. Until the time they went off feed, they had gained at the same rate as those in Lot 2, but slightly more slowly than did those in Lot 3. Considering the entire 202-day feeding period, the rate of gain in all lots was practically the same, or less than one-tenth pound per day difference.

Cost of gain varies with feed prices. Two price levels were used to compute costs as indicated. Dry matter content in alfalfa silage was one-third that in the hay, and prices charged were in that proportion.

Cost of gain was cheapest in Lot 2 in each division of the feeding period and most expensive (only slightly, however) in Lot 1 in each case. In fact, cost in Lot 2, with the higher-priced feeds, was practically the average of the costs in the other two lots at the low feed prices.

The increase of 25 per cent in feed prices, which was the difference in the two price levels used in the table, resulted in \$1.26 to \$1.59 increase in cost of 100 pounds of gain. The lower increase was for the corn silage-lot and the greater increase for the hay-lot.

Comparing the amounts of feed required to make gains on the calves, 787 pounds of alfalfa hay in Lot 1 were equivalent to 1 ton of alfalfa silage in Lot 3.

Similarly, 585 pounds of corn and 632 pounds of hay in Lot 1 were equivalent to 1 ton of corn silage and 125 pounds of cottonseed meal in Lot 2.

One ton of corn silage, with 174 pounds of alfalfa hay and 125 pounds of cottonseed meal in Lot 2 were equivalent to 2,045 pounds of alfalfa silage and 583 pounds of corn in Lot 3.

Discussion of Results

Cost of the calves in the feed-lot when the experiment started was \$9.40 per hundred pounds, including cost in Chicago, freight to East Lansing, and feed for two weeks. Market prices at the conclusion of the test were assigned by commission men from Detroit, Buffalo and Chicago; and were as follows: Lot 1, \$9.00; Lot 2, \$9.10; and Lot 3, \$9.25.

Table 4 shows the balance left above total cost of calf and feed, when gains made by pigs from undigested corn are credited and when all feeds are charged.

Possible values which could be credited to the hay or silage when other feeds are charged at the prices indicated are also shown in this table.

Calves fed corn silage gave a higher return above feed cost and a higher value per ton of silage than those fed alfalfa silage. In fact,

Table 4. Financial Statement.

	Lot 1	Lot 2	Lot 3
	Alfalfa Hay	Corn Silage	Alfalfa Silage
Initial cost per calf at \$9.40.....	\$35.11	\$35.65	\$36.23
Low-priced feeds:			
Feed cost.....	23.35	19.00	22.91
Calf and feed cost.....	58.46	54.65	59.14
Pig gains at \$5.00 per cwt.....	.53	.46	.58
Cost—crediting pork.....	57.93	54.19	58.56
Necessary selling price in lots.....	7.86	7.18	7.73
Selling price in lots.....	9.00	9.10	9.25
Return above feed costs—per head.....	8.37	14.46	11.55
Return per ton of hay or silage (Crediting all returns above other feed costs).....	18.00	10.70	7.96
Higher-priced feeds:			
Feed cost.....	\$29.16	\$23.72	\$28.60
Calf and feed cost.....	64.27	59.37	64.70
Pig gains at \$5.00 per cwt.....	.53	.46	.58
Cost—crediting pork.....	63.74	58.91	64.12
Necessary selling price in lots.....	8.65	7.81	8.48
Selling price in lots.....	9.00	9.10	9.25
Return above feed costs—per head.....	2.56	9.74	5.99
Return per ton of hay or silage (Crediting all returns above other feed costs).....	13.06	9.50	6.08

at the higher feed prices, the calves fed corn silage made a larger return per head than those fed hay with feed charged at the lower scale of prices.

Likewise, a higher value was indicated for a ton of corn silage with other feeds charged at the higher prices than was indicated for a ton of alfalfa silage with corn charged at the lower price.

A higher return per head, and also for an equal amount of dry matter in the roughage, was shown by those calves fed alfalfa silage than by the hay-fed group.

If selling prices of all lots had been the same, the same order of desirability of the three feeds would prevail; however, the comparative value of hay would rise and that of alfalfa silage would fall slightly.

The following observations were made regarding results of the previous experiment described in the Quarterly Bulletin for August 1939 and appear to be substantiated further by this test, although the advantage of alfalfa silage as compared with hay has been less.

“Results of this one experiment indicate that alfalfa-clover silage made with beet molasses is a more desirable feed for fattening steers than hay made from a similar crop.

“Legume silage and corn silage were not interchangeable in the steer ration.

“More than one pound of grain per day per hundred pounds of steer weight must be added to a legume hay or a legume silage ration in order to produce gain and finish equivalent to that obtained when steers are full-fed well-cared corn silage and hay, balanced for protein with cottonseed meal.”

It was not necessary, however, to add a protein-rich feed to the hay ration in the second trial in order to obtain satisfactory gain.

JOURNAL ARTICLE ABSTRACTS

Progress Report on Induced Parthenocarpy in Some Horticultural Crops—Wong, C. Y.—*Am. Soc. Hort. Sci. Proc.* 37: 158-160. 1939 (1940). [Journal Article No. 353 (n. s.) from the Michigan Agricultural Experiment Station.]—Seedless fruits of a number of varieties of watermelon, squash, cucumber and eggplant were obtained by treating stigmatic surfaces or cut styles of the flowers with certain hormones such as naphthalene acetic acid or acenaphthene. In certain varieties embryo-less seeds developed in the fruits resulting from the treatments. In many instances better development was obtained by using a mixture of two or more growth-promoting substances than by using only one.

An Osmic Impregnation Method for Mitochondria in Plant Cells—Newcomer, E. H.—*Stain Technology.* 15 (3): 89-90. 1940. [Journal Article No. 362 (n. s.) from the Michigan Agricultural Experiment Station.]—A technic is described in which chondriomes and proplastids are differentiated by the use of osmium tetroxide.

The Value of Sodium Metaphosphate in Detergent Mixtures in the Cleaning of Milking Machines—Mallmann, W. L., Bryan, C. S. and Bege-man, L. H.—*Jour. Dairy Sci.* 23 (7): 621-629. 1940. [Journal Article No. 363 (n. s.) from the Michigan Agricultural Experiment Station.]—The value of a detergent containing sodium metaphosphate as a means of maintaining clean milking machines was measured bacteriologically by comparing the plate and microscopic clump counts from machines cleaned with a sodium metaphosphate detergent with those obtained from machines cleaned with other detergent mixtures. It was demonstrated under actual farm conditions that the sodium metaphosphate detergent was highly effective as a cleaning agent and made possible the production of relatively low count milk.

Influence of Organic Acids, Sugars, and Sodium Chloride Upon Typical Strains of Food Poisoning Staphylococci—Nunheimer, T. D. and Fabian, F. W.—*Am. Jour. Public Health.* 30 (9): 1040-1048. 1940. [Journal Article No. 378 (n. s.) from the Michigan Agricultural Experiment Station.]—Since Staphylococci, as a group, are more resistant to physical and chemical agents than are some of the asporogenic bacteria suspected in outbreaks of food poisoning, a study was made of the resistance of typical strains to some of the chemical agents commonly found in food, such as acids, sugar and salt. It was found that, although the action of the highly dissociated mineral acid is due mainly to hydrogen ion concentration, the organic acids exerted a germicidal and antiseptic effect disproportionate to the hydrogen ion concentration produced. The decreasing order of germicidal action of the acids was found to be acetic, citric, lactic, malic, tartaric, hydrochloric. Decreasing order of antiseptic action was found to be acetic, lactic, citric, malic, tartaric, hydrochloric. Sodium chloride in a con-

centration of 15 to 20 per cent exerted an inhibiting effect, a 20 to 25 per cent concentration showed a definite germicidal action. Dextrose has an inhibitive effect in a concentration of 30 to 40 per cent and a germicidal effect at 40 to 60 per cent. Sucrose is less active than either dextrose or sodium chloride, because a concentration of 50 to 60 per cent was required for inhibition and 60 to 70 per cent for germicidal action. With mixtures of sugars and acid or salt and acid, it was found that dextrose was the most effective in lower concentrations.

A Breed Difference in the Manganese Requirement of Laying Hens—

Golding, W. V., Schaible, P. J. and Davidson, J. A.—Poultry Science. 19 (4) 263-269. 1940. [Journal Article No. 404 (n. s.) from the Michigan Agricultural Experiment Station.]—On manganese-deficient rations, Barred Rock hens produced eggs of markedly lower hatchability and with a greater incidence of chondrodystrophic embryos than White Leghorns. Manganese added to the ration corrected this condition and increased egg production in both breeds. It is concluded that Barred Rocks are more sensitive to a manganese deficiency than White Leghorns.

A Study of an Epidemic of Brucellosis Due to *Brucella melitensis*—

Huddleson, I. F. and Munger, M.—Am. Jour. Public Health. 30 (8): 944-954. 1940. [Journal Article No. 412 (n. s.) from the Michigan Agricultural Experiment Station.]—During the brucellosis epidemic which occurred at the Michigan State College in the winter of 1938-39, 45 individuals developed the clinical form, and possibly 49 the subclinical form of the disease. Of the 45 clinical cases, 41 were students, 1 a stenographer, 1 a plumber, 1 a stockroom attendant and 1 a salesman. *Brucella melitensis* was cultured from the blood of 36 of the clinical and 3 of the subclinical cases. No other species of *Brucella* was involved.

All possible sources of the infective material responsible for the epidemic are mentioned and discussed. It is pointed out that if the infecting organisms came through the water supply of the building because of back-siphonage, certain conditions affecting the water supply would have to exist almost simultaneously. There was no proof obtained that any of the conditions necessary for back-siphonage had occurred in the building during the fall and winter of 1938. The most convincing evidence in support of the hypothesis of mass infection is the occurrence of the majority of both the clinical and subclinical cases in three laboratory classes. The hypotheses that have been offered to explain the source of infective material, when subjected to a critical analysis, lack sufficient proof to explain how the epidemic originated.

The results of the different laboratory diagnostic tests show that no one test is always sufficient to confirm the diagnosis of clinical brucellosis shortly after onset. The combined results of all the laboratory tests show that active infection and clinical infection are not synonymous. One may be infected with *Brucella*, and yet never show clinical symptoms of the disease.

The Effect of Holder and Flash Pasteurization on Some Flavors of Milk. I. The Effect on Miscellaneous Flavors Common to Commercial Raw Milk—MacCurdy, R. D. and Trout, G. M.—Jour. Dairy Sci. 23 (9): 843-854. 1940. [Journal Article No. 419 (n. s.) from the Michigan Agricultural Experiment Station.]—Samples of milk from

each of 10 producers were obtained weekly over a six-months period and were holder-pasteurized with and without aeration at 143° F. for 30 minutes and flash-pasteurized at 160° F. for 15 seconds. The samples were scored and rescored "blind" at the first and third days of storage by two judges working independently.

The predominating off-flavor in the day-old control samples was "feed," the percentage frequency of which was materially decreased by pasteurization. The predominating off-flavor of unaerated and aerated holder-pasteurized day-old milk was "heated". Fewer "heated" flavors were noted in the flash-pasteurized samples. Flash-pasteurized milk showed not only a higher percentage of observations of excellent flavor milk, score of 23, than were noted in the raw control or in the holder-pasteurized samples but greater stability of excellent flavor upon storage.

The pasteurization process increased the frequency of heated, oxidized, cooked, and old flavors and decreased the frequency of feed, high-acid, flat, salty, cowy, rancid, unclean, and off but unidentified flavors.

Storage of the milk at 40° F. for three days increased the frequency of high-acid, old, oxidized, unclean, and rancid flavors in the raw samples and the oxidized and old flavors in the pasteurized samples, whereas similar storage decreased the percentage incidence of feed, cowy, flat, heated, cooked, and off but unidentified flavors.

The mean score of the raw milk of all patrons decreased steadily from January through June. A gradual increase in the incidence of feed flavors was found in the raw samples from January to June. During the same period of time there was noted a rather constant frequency of oxidized flavors in the samples of the pasteurized milk, until May when the frequency decreased markedly. As the frequency of feed flavors increased, a very similar decrease in the occurrence of the oxidized flavors was noted.

The Effect of Holder and Flash Pasteurization on Some Flavors of Milk. II. The Effect on Corn and Alfalfa Silage Flavors—MacCurdy, R. D. and Trout, G. M.—*Jour. Dairy Sci.* 23 (9): 855-860. 1940. [Journal Article No. 420 (n.s.) from the Michigan Agricultural Experiment Station.]—When cows were fed a given quantity of silage the feed flavor was more intense in that milk from the cows of least production. Feed flavors were noted in the milk when 0.79 pound of corn silage or 0.40 pound of alfalfa silage per pound of milk produced were fed to the cows one hour before milking.

Alfalfa and corn silage flavors in milk were lessened in intensity by holder pasteurization. However, strong silage flavors were not entirely eliminated by the process employed. Vacuum holder pasteurization and forced aeration holder pasteurization were superior to unaerated or aerated holder pasteurization in removing corn and alfalfa silage flavors from milk. These processes were superior also to flash pasteurization in removing corn silage flavor from milk. Unaerated and aerated holder pasteurization resulted in a greater frequency of oxidized flavors in the stored milk than did vacuum pasteurization.

A small quantity of silage flavored milk may not necessarily taint the flavor of a large batch of processed milk. Sufficient excellent flavor milk may be added to the silage milk to reduce the intensity to the extent that pasteurization will remove the flavor entirely.

Soil Profiles in Relation to the Recession and Extinction of Michigan Lakes—Veatch, J. O.—*Soil Science*. 50 (2): 103-110. 1940. [Journal Article No. 435 (n. s.) from the Michigan Agricultural Experiment Station.]—Since Michigan has a very large number of natural lakes and since these have recreational and other values, a study of the phenomena of recession and extinction has both a scientific and economic justification. A study of the soil profiles of lakes and former lake beds may aid in the formulation of explanations and theories for rate and time of recession and extinction of lakes. A number of types of recession are illustrated and also a series of soil profiles from the water covered condition to the mature profile for this region. From a study of the more detailed soil maps of the state, the conclusion is reached that the extinction of lakes has probably taken place since early post-Glacial time and is not a phenomenon of recent occurrence only. Pedologic evidence amplifies other kinds of evidence that there is a persistent trend toward extinction due to natural causes.

The Neutralization of Cream for Buttermaking. Part I—The Accuracy of Acid Reduction by Various Neutralizers—Townley, R. C. and Gould, I. A.—*Canadian Dairy and Ice Cream Journal*. 19 (5): 54, 56, 58 and 60. 1940. [Journal Article No. 436 (n. s.) from Michigan Agricultural Experiment Station.]—Cream of approximately 0.5 per cent acidity was calculated to be neutralized to ranges from 0.0 to 0.25 per cent with sodium carbonate, sodium bicarbonate, proprietary brand "A" (Recto), proprietary brand "B" (Wyandotte C.A.S.), sodium hydroxide, calcium hydrated lime and magnesium oxide lime. These neutralizers were found to vary appreciably in the accuracy of acid reduction. At the higher acidity ranges the acid reduction in the cream was often somewhat greater than the calculated reduction when either sodium hydroxide, calcium lime or magnesium lime was used. The other neutralizers, with the exception of sodium bicarbonate which was only 91 per cent efficient in reducing cream to 0.25 per cent acidity, gave results fairly close to the theoretical value. However, when attempts were made to neutralize cream to low acidities none of these compounds gave the expected reduction. In general, the lower the acidity reduction desired, the greater the inefficiency of the reduction, with the sodium hydroxide and limes being more efficient in acid reduction throughout the range than were the carbonate compounds.

Considerable variation occurred in the pH of the neutralized cream when the different neutralizing agents were used. In order to obtain a pH of about 6.8 in the cream with each of these neutralizers, the following calculated acidities would be necessary: sodium carbonate, 0.09; proprietary brand "A", 0.12; proprietary brand "B", 0.17; sodium hydroxide, 0.19; calcium hydrated lime, 0.07; and magnesium oxide lime, 0.10.

The pH of the butter was usually always above the pH values of the corresponding cream, the difference usually being from 0.1 to 0.2 pH units.

The Neutralization of Cream for Buttermaking. Part II—The Speed of Acid Reduction and Influence of Pasteurization Temperature—Townley, R. C. and Gould, I. A.—*Canadian Dairy and Ice Cream Journal*. 19 (6): 50, 52, 54 and 56. 1940. [Journal Article No. 437 (n. s.)]

from the Michigan Agricultural Experiment Station.]—The time necessary for acid reduction and the influence of pasteurization temperature on the efficiency of acid reduction by different neutralizing agents on cream of approximately 0.5 per cent acidity was found to be influenced by the amount and kind of neutralizer employed.

The reaction between any one of the neutralizers and cream held at 90° F. is almost as complete after five minutes as it is after 20 minutes. Therefore, it appears that a holding period longer than five minutes may be unnecessary, except in cases where a large amount of magnesium lime is used.

When cream is heated and cooled in a vat, pasteurization temperatures of 145° F. for 30 min., 160° F. for 15 min., and momentarily at 180° F. were found to exert similar influences on acid reduction of neutralized cream. There was no appreciable acid reduction during pasteurization when the cream was neutralized with either sodium hydroxide or calcium lime. However, the acid reduction due to pasteurization generally became progressively greater as the amount of either a carbonate neutralizer or magnesium lime added to cream was increased. This reduction amounted to approximately 0.10 per cent for carbonates and 0.05 for magnesium lime when the acidity desired was 0.00 per cent.

A Comparison of the Petering-Wolman-Hibbard Procedure for Determining Carotene, and Two Modifications Thereof, with the Peterson-Hughes-Freeman Technique—Benne, E. J., Wolman, W., Hibbard, R. P. and Miller, E. J.—*Jour. Assoc. Official Agricultural Chemists*. 23: 709-716. 1940. [Journal Article No. 439 (n.s.) from the Michigan Agricultural Experiment Station.]—A method recently published by Petering, Wolman and Hibbard of this station permits the determination of both chlorophyll and carotene in the same sample of plant tissue. The finely ground tissue is extracted with an aqueous-acetone solution, which is made to volume, and both pigments are determined in this extract by means of a photometric colorimeter. Chlorophyll is determined directly in the extract by use of proper light filters in the instrument; whereas, carotene is determined, likewise by photoelectric means, in a petroleum ether extract of an aliquot of the same solution after chlorophyll is removed by barium hydroxide and the xanthophyll and flavones are separated from carotene by the usual methods.

Since this procedure offers obvious advantages in determining both of these constituents, as well as a saving of time compared to some of the older methods for determining carotene alone, it seemed important to ascertain how carotene values so obtained compared with those secured by the Peterson-Hughes-Freeman modification of the Guilbert method, which at present is being widely used for this purpose.

During this study two modifications of the Petering-Wolman-Hibbard technique, designed to lessen both the time and work required for determining carotene only, were initiated. In the first modification, extraction of the tissue and removal of chlorophyll were accomplished simultaneously by placing the sample in the thimble, and barium hydroxide in the flask, of a Soxhlet extraction apparatus. During refluxing the pigments were extracted and carried to the barium hydroxide, which separated the chlorophyll from the carotenoids. In the second, still simpler modifications of the original procedure, the ground

sample was placed in contact with the barium hydroxide in the aqueous-acetone solution, and the mixture was refluxed to extract the pigments and separate the chlorophyll as it was removed from the tissue.

This paper presents results of carotene determinations on a variety of plant tissues by the Petering-Wolman-Hibbard procedure and the above-described modifications thereof, as compared with those obtained by the Peterson-Hughes-Freeman technique. Results obtained by both the original and modified procedures were comparable with those by the Peterson-Hughes-Freeman technique, except with samples of blue-grass taken late in the season, in which the latter method appeared to give consistently lower results. The reason for this discrepancy is not definitely known, but is possibly due to interference of resinous substances precipitated during saponification with alcoholic alkali, rendering extraction of carotene from the residue with petroleum ether difficult.

Control of Flavor in Milk Heated to High Temperature—Gould, I. A.—*The Milk Dealer*. 29 (8): 70, 72, 74-76. 1940. [Journal Article No. 442 (n. s.) from the Michigan Agricultural Experiment Station.]—Milk was heated to 180° F., treated with quantities of copper salts from 0.5 to 2.0 p.p.m. and then homogenized at 2500 pounds pressure. When 1.5 to 2.0 p.p.m. of copper were used the milk possessed no appreciable cooked flavor after 24 hours of storage and the milk was fine flavored even after 120 hours of storage. The milk which contained no added copper retained a pronounced cooked flavor throughout the storage period, whereas milk which contained 1.5 p.p.m. of copper but which was not homogenized developed an oxidized flavor. The cooked flavor disappeared slightly more rapidly if the copper was added at 145° F. than when added at 180° F. Somewhat similar results were obtained when the copper was added after homogenization. These studies indicate the possibilities of preparing a soft curd milk as produced by heat and homogenization, without the disagreeable off-flavor which such milk usually possesses.

Salting of Green Tomatoes—Fabian, F. W. and Erickson, F. J.—*Fruit Products Jour.* 19 (12): 363-7, 377, 379. 1940. [Journal Article No. 446 (n. s.) from the Michigan Agricultural Experiment Station.]—The salting of green tomatoes presents a problem slightly different from that of the salting of cucumbers and cabbage because green tomatoes contain less fermentable carbohydrates. Cabbage, cucumbers and green tomatoes contain average percentages of 3.4, 2.57 and 0.99 per cent, respectively, of sugar.

Two methods may be used for salting green tomatoes. One is to add sufficient salt (40 to 50° salometer brine) to exclude spoilage bacteria. This permits little or no fermentation by acid-forming bacteria; consequently little acid is produced and the color and texture of the tomatoes is not satisfactory. The other method is fermentation at a low salt content (25 to 30° salometer). This permits growth of acid-producing bacteria. The tomatoes are cured more satisfactorily and have a better color and texture. Owing to the low sugar content of green tomatoes, it is advisable to add some form of fermentable carbohydrate, such as sucrose or dextrose. In these experiments dextrose was used.

Sufficient dextrose should be added so that the total amount present will at least equal the amount normally present in cucumbers. This insures a more rapid production, and in some cases a greater amount, of acid in the fermentation.

These experiments would indicate that the best fermentation occurred in a 30-degree salometer brine to which had been added 2.5-per cent dextrose by weight of the green tomatoes.

Sulfanilamide in the Treatment of Streptococcic Mastitis—Bryan, C. S. and Arnold, J. J.—Vet. Med. 35 (9): 508-511. 1940. [Journal Article No. 453 (n. s.) from Michigan Agricultural Experiment Station.]—Sulfanilamide when administered for 12 days to five cows at the rate of 0.3 gr. per pound per day, to four cows at the rate of 0.6 gr. per pound per day, and to four cows at the rate of 1.2 gr. per pound per day, all the cows being affected with chronic streptococcic mastitis, did not affect the streptococcic infection of the udder. The number of streptococci eliminated in the milk decreased during treatment, but in all cases the numbers subsequently returned to the levels prior to treatment.

Sulfanilamide given for 12 days at the rate of 0.6 gr. per pound per day to one cow and 1.2 gr. per pound per day to another cow was very effective in relieving the systemic reaction in acute streptococcic mastitis, as indicated by the decrease in body temperature and the return of the cow's appetite. The larger dose was the more effective; for although in the cow so treated the reaction was more severe (as indicated by a temperature of 107° F., compared to 105° F. for the cow receiving the smaller dose), the symptoms subsided more rapidly and the cow returned to the milking line, producing more milk than did the cow receiving only 0.6 gr. per pound per day.

Sulfanilamide is apparently quite toxic for cows in repeated large doses. Calcium gluconate solution may be a reliable antidote to sulfanilamide poisoning in cattle.

Effect of Carbon Dioxide on the Growth of Meat Spoilage Organisms at Low Temperatures—Mallmann, W. L. and Zaikowski, L.—The National Provisioner, August 17: 16-17. 1940. [Journal Article No. 454 (n. s.) from the Michigan Agricultural Experiment Station.]—Seventy-four cultures were isolated from beef. These cultures belonged to the following genera: *Micrococcus*, *Flavobacter*, *Bacillus*, *Achromobacter*, *Diplococcus*, *Gaffkya*, *Staphylococcus*, *Bacterium* and *Sarcina*. These cultures were placed in refrigerators at a temperature of 3-5° C. in the presence of 2.5, 5 and 10 per cent carbon dioxide to determine the antibiotic effect of the gas. Control cultures were placed in a refrigerator at the same temperature in the absence of carbon dioxide. All the organisms multiplied in the absence of carbon dioxide. In an atmosphere of 10 per cent carbon dioxide the bacteria decreased in numbers. In an atmosphere of 2.5 per cent carbon dioxide some bacteria grew very slowly. The data indicate that the use of 2.5 per cent carbon dioxide atmospheres in meat storage boxes would prolong the keeping quality of the meat.

BULLETIN REVIEWS

Circ. Bul. 172—Floor Finishes—Jefferson, C. H.—No single finish has been found that may be used on all types of flooring. The penetrating floor seals discussed in this bulletin are adapted to wood, concrete and linoleum floors. For those flooring materials, penetrating seals are rapidly replacing other types of floor finishes, owing to their greater durability, simple maintenance and lower cost. The bulletin also contains directions for finishing other flooring, such as asphalt tile, printed linoleum and rubber, and for refinishing the surface of old wood floors. (22 pp., 10 figs.)

Circ. Bul. 173—Silage from Forage Crops—Making It—Feeding It—Dexter, S. T. and Huffman, C. F.—In some sections of Michigan, the climate, soil or the hilly topography make corn less productive and more expensive as a feed crop than suitable legume and grass mixtures. The production of alfalfa and other hay-crop silages reduces the hazards of harvest in any region, since losses by shattering and leaching are avoided and crops may be cut at the proper stage regardless of the weather. When part of the hay crop is ensiled for feed, increased acreages of soil conserving crops are practicable. Any crop that makes good feed may be ensiled successfully if the moisture content of the silage approximates 65 or 70 per cent. Too-wet silage may ferment poorly while too-dry silage is likely to mold. The green hay may be loaded direct from the swath with a heavy-duty rake-bar type loader and every effort should be made to save labor in handling this heavy crop.

On mixed alfalfa and grass hay, from 40–60 pounds of molasses per ton of green material is recommended as a preservative. Phosphoric acid has been used successfully as a preservative as well.

Yields of dry matter per acre from good alfalfa fields are frequently equal to or even greater than that of corn. (Three tons of silage are equal to one ton of dry hay.)

Alfalfa silage or grass silage may be fed in place of all the corn silage or in place of part of the hay. Cows will consume more dry matter if fed some hay along with the silage than if fed either alone. To avoid odors in the milk, feed silage immediately following morning milking and keep mangers clean. (8 pp. 3 figs.)

Spec. Bul. 303—Self-Feeding vs. Hand-Feeding Fattening Lambs and Rations for Self-Feeding Lambs—Brown, G. A. and Blakeslee, L. H.—Lambs hand-fed a full feed of shelled corn and first cutting alfalfa hay made approximately the same gains, were equally well finished and had a lower death loss than similar lambs self-fed the same feeds. The hand-fed lambs used a larger amount of roughage and less grain per hundred pounds of gain than did the self-fed lambs.

The use of either ground or cut alfalfa hay as a bulking agent, with cracked corn, fed in the self-feeder resulted in a lower death rate, but a higher cost per pound of gain produced than was the case when

shelled corn and long alfalfa hay were fed. Ground alfalfa hay proved more satisfactory as a bulking agent than did either cut alfalfa hay, oat hulls or corncobs fed as corncob meal.

Cafeteria feeding of linseed meal along with shelled corn, bran and oats resulted in expensive gains owing to a heavy consumption of the linseed cake. The use of a grain ration consisting of one part linseed cake to seven parts shelled corn did not prove so profitable as shelled corn alone when both rations were fed with alfalfa hay.

With lambs selling from \$5 to \$10 per hundredweight, a margin or increase of sale price over purchase price was necessary to give a satisfactory return for feeds fed.

Tech. Bul. 173—A Study of Some Factors Affecting the Efficiency of *Encarsia formosa* Gahan, an Aphelinid Parasite of the Greenhouse White Fly, *Trialeurodes vaporariorum* (Westw.)—Milliron, H. E.—Studies on the bionomics of *Encarsia formosa*, a parasite (parasitoid) on the greenhouse white fly *Trialeurodes vaporariorum* indicate little likelihood of control of *T. vaporariorum* by *E. formosa* in greenhouses containing a variety of plants of varying growth habits. There are indications that under certain conditions, i. e. proper temperature and high initial parasite population, *E. formosa* definitely checks rapid increase of the host.

Apparently temperatures of 75°–79° F. and relative humidities of 50–70 per cent are most favorable. Temperatures below 64° F. bring about marked sluggishness and lowered efficiency. Temperature, humidity and light are important as physical environmental factors, in the order named.

Degree of pubescence of the host plant and excretions by host plant and parasite also influence the degree of parasitism. (23 pp., 6 tables, 10 figs.)

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Four series of publications are issued by the Michigan Agricultural Experiment Station—Circular, Special, Technical, Quarterly—and the Extension Division issues an Extension series, and also a series designed especially for Boys' and Girls' 4-H Club members. The **Extension** (E) bulletins and the **Circular** (C) bulletins are popularly written articles of information on the subjects indicated. Their subject matter is based on the results of investigations at the Experiment Station and on other sources of information. The **Special** (S) bulletins report on specific investigations conducted by the Michigan Station. They are written in popular style so as to be of use to farmers and others interested in the subjects in question. The **Technical** (T) bulletins likewise report on specific investigations of the Michigan Station but deal with subjects that from their very nature must be described in more or less technical language. They are printed in small editions and are intended especially for libraries, investigators, teachers, extension men, county agricultural agents and other specialists who may have use for them. The **Quarterly** bulletins contain timely articles of information for farmers, based largely on the work of the Agricultural Experiment Station.

A mailing list is maintained to whom the Quarterly bulletins are regularly sent. They are free to residents of Michigan. A charge of 25¢ per year is made to those outside the state. Remittance may be made in stamps or coin. Bulletins of the other series are sent only upon specific request, except to a small list consisting of libraries, experiment stations, extension workers, county agricultural agents, and newspapers.

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of the Michigan State College**

East Lansing, Michigan

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EDITED BY
V. R. GARDNER AND A. A. APPLIGATE

CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION

SOME GROWTH CHARACTERISTICS OF PERENNIAL HAY AND PASTURE CROPS

ADJUSTING PASTURING AND CUTTING PRACTICES TO THEM

In a state in which dairying and livestock raising are dominant farm enterprises the general question of pasture and meadow management is one of the most important with which the farmer has to deal. With a scanty, sparse growth of vegetation of low nutritive value on native pastures, more expensive cultivated row crops or purchased concentrates have been resorted to and the margin of profit correspondingly reduced or perhaps eliminated. With luxurious growth of highly nutritious pasture and hay crops both feed and labor costs may be kept relatively low and more substantial profit margins realized.

In the main, efforts to increase the returns from pasture land and meadows have taken two directions or, perhaps more accurately, have approached the problem from two angles: (1) through seeding to introduce more valuable kinds of legumes and grasses and to provide a heavier stand of plants, and (2) through fertilizer applications, which, in addition to their mass effect on yield, encourage the growth of the better kinds in the stand. Much has been accomplished by these methods and there still remains a relatively large percentage of grazing land and hay fields that can be greatly benefited by their continued use. Both practices are based on the theory that the cropping of a pasture or meadow is essentially a problem in addition and subtraction. Seed is sown, fertilizers are applied and then plant tissue, produced from the seed and the fertilizer, together with water and other materials obtained from the soil, is harvested. The greater the additions of fertilizer and perhaps seed—and rainfall—the greater, theoretically at least, the subtraction in the form of crops. Because the growing plant utilizes soil moisture and many of the mineral elements in the soil, as well as the seed and fertilizer, in its growth, a pound of seed or of fertilizer may be returned two-fold or ten-fold or a hundred-fold, as the case may be.

Pasture and Meadow Management Something More than a Problem in Addition and Subtraction—This concept of crop production as a rather simple problem in addition and subtraction, basically sound so far as it goes, does not, however, present the whole picture, for it leaves out of consideration the fact that the main bulk of the plant's tissue that is removed in the crop is neither the mineral nutrients obtained from the soil nor the minute quantities of organic food materials that have migrated from the seed into the plant's leaves and stems. Instead, the main bulk of the crop—80 to 95 per cent of its dry weight—is organic matter in the form of such substances as fiber, cell wall, sugar, starch, protein, fat, pigments. These substances the plant itself must synthesize or manufacture, principally out of water from the soil and the carbon dioxide that it gets from the air, with

the aid, to be sure, of the essential mineral elements from the soil. For this manufacturing process, the plant depends almost entirely upon its leaves. With a large leaf surface food manufacture goes on rapidly (temperature, light, moisture supply and other environmental conditions being favorable); with a limited leaf surface it is correspondingly slowed down; when there are no leaves present it comes to a standstill. With ordinary field and garden and tree crops about everything one does to them in the way of culture, from cultivation and fertilizing on the one hand to pruning and spraying on the other, is for the purpose of enabling them to develop a maximum leaf surface and then protecting those leaves from injury, to the end that they may manufacture maximum amounts of such materials as starch, fats, proteins, that go to make up the crop, be that crop leaves, fruits, seeds, roots or tubers. With the pasture crop the procedure is almost the opposite in both method and effect. Ordinarily there is a continuous reduction in leaf surface and with close pasturing there is virtually complete defoliation. Figuratively speaking, this is "killing the goose that lays the golden eggs". Yet from the very nature of the case that is just what grazing must be—a steady subtraction of leaves and stems that the plant is more or less vainly producing in order to attain its normal stature and complete its growth.

Moderate vs. Close Grazing—Does this mean, then, that an acre of pasture land can yield only a small fraction of an equal area devoted to raising some field or garden crop. The answer is "no"—an answer that has been gradually worked out to their own satisfaction by thousands of observant farmers in their own fields, though probably few of them have attempted to explain their procedure in terms of starch or other root reserves. Farmers whose animals on pasture have been able "to have their cake and eat it too" have steered a kind of middle course in their grazing practice. More specifically, they have carefully refrained from too close grazing so that at all times the plants have had sufficient foliage to manufacture the food materials from which new growth can be produced. Consequently new growth has about kept pace with defoliation and both growth and defoliation processes have been maintained at a high level, because at no time were the plants permitted to become completely, or even almost, defoliated and hence too weak for recovery. It has been a matter of addition and subtraction, but those farmers have been careful not to subtract faster than the plant has added. There has been maintained at all times a good reserve "in the bank".

The basic principles of plant growth underlying this procedure are well brought out by a series of experiments conducted during recent years by the Section of Farm Crops of the Michigan Agricultural Experiment Station in which alfalfa and a number of forage grasses—including timothy, orchard grass, quack grass, brome grass and bluegrass—were clipped at various heights at suitable intervals and rates of recovery studied. Without exception close clipping (to one inch) resulted in almost complete cessation of new growth and in some instances promptly led to the death of the plants. Light clipping (to 4 or 6 inches) often, though not always, reduced somewhat the total amount of vegetation, as compared with unclipped plants, but always enabled them to recover promptly and to grow rapidly. Thus

in the case of one experiment with alfalfa plants, clipping back (the equivalent of pasturing) to 2 inches in height gave total yields equivalent to nearly 90 per cent of those allowed to grow to maturity without clipping, while clipping to a height of one inch reduced total yield to less than 15 per cent normal.

Perhaps more important than conservative spring and summer grazing in the management of pastures is special care to avoid depletion of the reserves in the roots and crowns in the fall. Studies at the Michigan Station have shown that September is a very critical month from the standpoint of how alfalfa will survive the winter and grow the next spring and summer—and this principle likewise holds for other perennial legumes and grasses, though the critical period varies somewhat with the different kinds. Under Michigan conditions close grazing at almost any time during this critical period forces the plants to use up virtually all of their reserves in making a late fall growth and then the low temperatures of October and November prevent the accumulation of new reserves of starch and sugar that will tide them through the winter and start them off in the spring. The result is much winterkilling of roots and crowns and a poor stand. On the other hand, **late** (October in the case of alfalfa) grazing, even though close, leaves the roots and crowns well-supplied with stored foods, because they are not used up in late fall growth of tops and they are in excellent condition to resume growth in the spring.

Fall Cutting of Hay Fields—Safe and Dangerous—The same principles apply to the removal of a second or third cutting of alfalfa or other hay crop during late summer or fall. Such a cutting does not harm the plants if made late enough in the season—for example early October—so that the roots and crowns are not depleted by making a subsequent fall growth, and a valuable hay crop is obtained. On the other hand, if the fall cutting is early enough so that a new flush of growth is produced in the fall, the reserve foods of roots and crowns are exhausted, the plants winterkill badly, recovery is poor in the spring, and the stand may be ruined.

The productivity of thousands of alfalfa fields in Michigan is seriously reduced and their life substantially shortened by the growers' failure to recognize these principles underlying the growth habits of the perennial pasture and forage crops and to adjust grazing and cutting practices to them. The science and art of grassland management depend to a considerable degree upon the recognition of the differences between various species. Thus, upright plants such as alfalfa and timothy are more readily defoliated by close grazing than are recumbent plants such as white clover and bluegrass. Very productive upright species prove very desirable as pasture plants, however, if grazed in accordance with their own habits of growth.

The reader who is interested in the publications based on the grazing, hay cutting and root reserve studies briefly summarized here is referred to the following:

1. Response of Quack Grass to Defoliation and Fertilization—Dexter, S. T.—*Plant Physiology*. **11**: 843-851. 1936.
2. The Effect of Late Summer and Early Fall Cutting on Crown Bud Formation and Winterhardiness of Alfalfa—Silkett, V. W., Megee, C. R. and Rather, H. C.—*Jour. Am. Soc. Agron.* **29** (1): 53-62. 1937.

3. A Study of the Time of Pasturing Alfalfa—Rather, H. C. and Dorrance, A. B.—*Jour. Am. Soc. Agron.* **30** (2): 130-134. 1938.
4. Alfalfa Management, with Special Reference to Fall Treatment—Rather, H. C. and Harrison, C. M.—*Mich. Agr. Exp. Sta. Sp. Bul.* 292. 1938.
5. Early Cutting and Fertilization of Quack Grass Meadows—Dexter, S. T. and Clanahan, D. L.—*Mich. Agr. Exp. Sta. Quart. Bul.* **21** (3): 176-179. 1939.
6. Starch Reserves in the Roots of Pastured Alfalfa when Grown Alone and in Mixtures—Rather, H. C. and Harrison, C. M.—*Mich. Agr. Exp. Sta. Quart. Bul.* **21** (4): 281-291. 1939.
7. Greenhouse Studies of the Effect of Clipping the Tops of Alfalfa at Various Heights on the Production of Roots, Reserve Carbohydrates and Top Growth.—Harrison, C. M.—*Plant Physiology.* **14**: 505-516. 1939.
8. Responses of Certain Perennial Grasses to Cutting Treatments—Harrison, C. M. and Hodgson, C. W.—*Jour. Am. Soc. Agron.* **31** (5): 418-430. 1939.

V. R. GARDNER, *Director*,

MICHIGAN AGRICULTURAL EXPERIMENT STATION.

MEASURING HYBRID CORN FOR MICHIGAN

1938-1940 TRIALS

H. C. RATHER AND A. R. MARSTON
SECTION OF FARM CROPS

According to a survey made by the United States Department of Agriculture, Michigan grew some 270,000 acres of hybrid corn in 1940. Undoubtedly the acreage planted to corn hybrids in this state in 1941 will be substantially larger than that in 1940. Hence, thousands of growers are interested in the relative characteristics, yielding ability and adaptation of the scores of hybrids being offered.

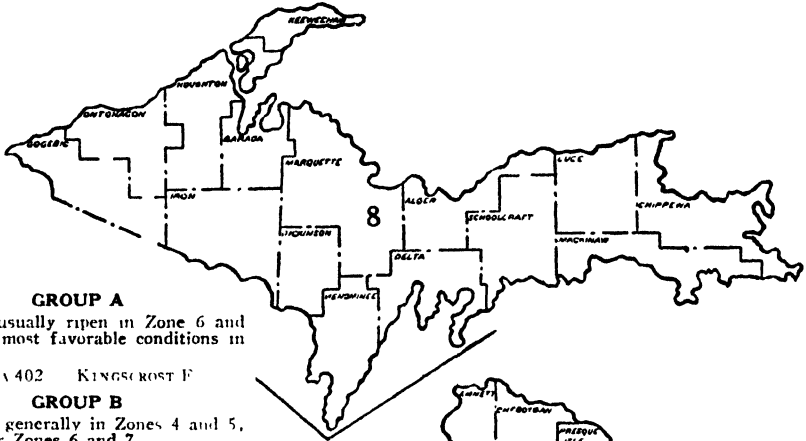
Tests under the direct supervision of the Michigan Agricultural Experiment Station are conducted each year in Monroe, St. Joseph, Ingham, Saginaw, Huron, Wexford and Otsego counties, to gain detailed information on corn hybrids, old and new, which may be of interest to Michigan corn growers. The Michigan Crop Improvement Association, county agricultural agents, farmers, and seedsmen have all contributed to the carrying on of these trials. Their diverse locations afford a reasonable representation of the range of Michigan corn growing conditions.

Method of Testing

Each variety tested at a given location appears in that test in five different places to reduce to a minimum variations in yield due to

ADAPTATION GROUPS

The corn hybrids listed below have appeared in at least one Michigan State College over-state trial in both 1939 and 1940. Its two-year average yield, in at least one trial, has been above average for all hybrids tested which were of similar maturity. The zoning of the map of Michigan is based on a study of records of normal weather during the corn growing season in this state. The adaptation of corn varieties is influenced by soil, cultural practices, and other factors besides weather so the zone divisions must be considered as general approximations rather than anything more specific.



GROUP A

Should usually ripen in Zone 6 and under the most favorable conditions in Zone 7.

MINNESOTA 402 KINGSROST F

GROUP B

Adapted generally in Zones 4 and 5, too late for Zones 6 and 7.

MICHIGAN 1218 KINGSROST D4
WISCONSIN 355

GROUP C

Adapted to northern part of Zone 3 and other locations in this zone needing early corn.

IOWEALTH 98 KINGSROST D
DEKALB 201 WISCONSIN 531
OHIO M-15 PIONEER 355

GROUP D

Adapted to favorable locations in the southern part of Zone 3, generally throughout Zone 2, and to parts of Zone 1, needing moderately early corn.

IOWEALTH 105 DEKALB 240
WISCONSIN 645 IOWEALTH A
OHIO K-23 IOWEALTH 95
KINGSROST FK FUNKS G-7

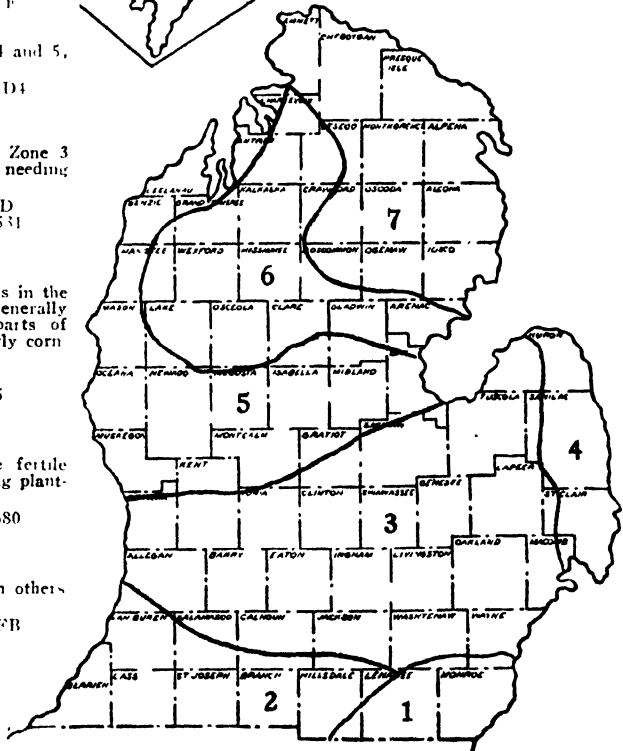
GROUP E

Should mature on the more fertile soils of Zones 1 and 2, providing planting is done by mid-May.

PIONEER 324 WISCONSIN 680
DEKALB 404A PIONEER 322
PIONEER 349 PIONEER 315
WISCONSIN 696

Apparently slightly later than others in Group E.

HOOSIERCROST 405 KINGSROST FB
INDIANA 416



soil differences. The ear corn of each variety is sampled for moisture content four different times in the fall to make possible an estimate of the time from date of planting until the ears are down to 40% moisture. At this stage of development, according to previous work,* growth ceases and the corn may be said to have reached maturity. Dent corn at 40% moisture is fully dented and, usually, it is so hard the kernels can scarcely be cut with the thumbnail. Usually the husks will have lost their green color but the stalks and leaves may still be green and succulent. Ear corn at 40% moisture is not ready to be husked. It should contain no more than 25 to 27 per cent moisture when put into the crib. Number 2 corn on the market must contain no more than 15.5% moisture.

A variety which has not fully matured by harvest or by the time of the first killing frost will not develop its fullest potential yield even though subsequently it may dry down satisfactorily for cribbing. However, late varieties for a given location in 1940, which still contained 40% moisture or more on October 1 were subjected to very poor drying conditions in October. At East Lansing a variety which contained 52% moisture on October 2 still had 45% moisture on October 22. Another with 48% moisture on October 2 still had 39% moisture on October 22. Even corn which was down to 40% moisture on October 2 was far too wet to crib on November 1. The problem of handling soft corn was very prevalent in the fall of 1940, whereas in 1938 and 1939 even late varieties dried early and rapidly.

Corn should at least be early enough to mature fully and dry safely in the average season. Some hybrids are being offered in Michigan in localities for which they are too late. They seemed satisfactory in 1939 and brought only trouble and dissatisfaction in 1940.

Hybrid Seed Not a Substitute for Fertility

During the 1940 season the Farm Crops Section received numerous reports of dissatisfaction with the productivity of certain hybrids. Ears were small and poorly filled, yields were low. The authors do not believe that any of the hybrids are inherently that bad. No kind of seed is a substitute for soil fertility or favorable seasonal conditions. If the productive level of a corn field is such that only a 25- or 30-bushel crop can be produced that field presents no particular seed problem. What the field needs is barnyard manure, a leguminous crop, and some fertilizer—or possibly it should never be used for corn. Under such conditions even the best of hybrids is certain to be disappointing. A fertile soil, the best of cultural practices, and a favorable season are essential to high corn yields. An adapted vigorous hybrid should make the most of favorable conditions of environment.

Interpreting Results

In the tables presented here, the yields of the varieties tested in 1940 are given. If these same varieties were also tested in 1939 and 1938 their two- and three-year average yields are given.

No one experiment in a single season, regardless of how well it

* Rather, H. C., and Marston, A. R.—A study of corn maturity, Mich. Agr. Exp. Sta. Quart. Bul. 22 (4): 278-288. May, 1940.



Fig. 1. Wisconsin Hybrid No. 645.

has been conducted, yields evidence which is fully conclusive with respect either to yield or maturity. The information concerning varieties tested only in 1940 is presented with full appreciation of the shortcomings of a single trial. **The most dependable information in this report is that based on three-year average performances.**

All yields are expressed in bushels of shelled corn at a uniform moisture content of 15.5%.

Maturity

The one satisfactory way of determining the adaptation of a new variety is to compare its performance with other corns of known merit. The varieties tested are listed in the accompanying tables, in their order of maturity with the earlier corns heading the list. Additional information gained in subsequent years may result in some changes in this arrangement, but the authors are confident that the earliest corns are near the top and the latest near the bottom of each list. Hybrids apparently of similar maturity have been grouped. In general, there is a range of about five days between the earliest and latest corn within each group.

MONROE COUNTY

For the last three years the Monroe tests have been conducted on the Monroe county farm, Walter Kraus, superintendent. The area for 1940 consisted of a rather uniform, level, sandy loam field. There was some infestation by the European corn borer but this difficulty was not of sufficient consequence materially to affect the yield.

Possibly some of the earliest varieties tested here are earlier than necessary for the better soils of southeastern Michigan, although Ohio K-23 in particular has given an excellent three-year performance.

Table 1. Yields of varieties tested in Monroe County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Minnesota 403	58.4		
DeKalb 240	55.2		
WISCONSIN 605	60.0	64.3	63.7
Wisconsin 645	60.0		
Iowearth A	56.2	68.9	
Kingscroat 176	57.2		
OHIO K-23	67.3	70.1	69.4
Ohio K-35	61.0		
DUNCAN, O. P.	14.1	53.5	55.7
Funks' G-7	65.1	69.1	62.7
DE KALB 202	57.5	60.6	62.7
KINGSCROST FK	57.2	66.0	66.5
Pioneer 324	58.4	73.6	
Wisconsin 678	61.9	67.7	
Wisconsin 680	60.2		
Funks' G-18	59.7		
WISCONSIN 696	65.1	71.3	72.8
DeKalb 410	66.4		
Michigan 21A	53.0		
DeKalb 404A	57.8	66.5	
WISCONSIN 676	54.9	65.7	68.2
PIONEER 322	64.5	70.9	78.2
Pioneer 315	63.8		
Hoosiercroat 405	61.9	71.1	
DeKalb 615	69.5		
Pioneer 330	51.1		
M & M 554	69.2		
IOWEALTH 100	58.1	68.6	67.9
INDIANA 416	49.0	70.1	75.4
KINGSCROST FB	66.7	73.1	69.1
Bender 348	45.4		
Iowearth AB	63.5	70.9	
Wisconsin 690	52.1		
Indiana 420	57.5		
Indiana 425	57.8		
Kingscroat KY	59.1		
Hoosiercroat 422	69.5	79.4	
Iowearth B	70.5	77.6	
National 116	63.5	76.9	
Pioneer 3307	57.8		
Indiana 610	66.4		
Hoosiercroat 461	59.7	69.6	
Hoosiercroat 668	60.0		
Red Cob Enslage, O. P.	36.5		

Planting dates: 1938—June 2
 1939—May 15
 1940—May 20

Harvest dates: 1938—Oct. 14
 1939—Sept. 27
 1940—Sept. 30

None of the later varieties has shown significant yield advantages over the leaders in the second group and use of these later corns increases soft corn hazards.

ST. JOSEPH COUNTY

In St. Joseph county these trials were conducted on the farm of Robert Robinson, near Mendon. Exceptionally favorable conditions prevailed in 1939 when yields in excess of 100 bushels shelled corn

Table 2. Yields of varieties tested in St. Joseph County.

Variety	Yield Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Minnesota 403	53 3		
DeKalb 240	55 2	79.5	
DeKalb 204	54 6		
IOWEALTH 105	49 5	79 4	77.3
WISCONSIN 606	43 2	68 8	63.4
WISCONSIN 645	48 3	72 4	71.1
Kingscrost 176	50 5		
OHIO K-23	62 2	84 4	77.2
Ohio K-35	54 9		
DUNCAN, O.P.	41 4	69 8	63.4
Iowealth A2	44 4	72 3	
Funks' G-7	42 5	71 6	
DeKalb (Exp 42)	48 9		
Fair's Yellow Dent, O P	50 8		
KINGSCROST FK	53 0	75 0	70.6
Pioneer 324	61 6	86.1	
Wisconsin 678	56 5	79.9	
WISCONSIN 680	61 6	84 6	79.3
Funks' G-18	43 8		
Michigan Wonder, O.P	45 7		
WISCONSIN 696	52 1	78 7	76.1
DeKalb 410	53 7		
Michigan 21A	45 0		
KINGSCROST FB	53 7	79 3	73.8
DeKalb 404A	51 4	82 9	
WISCONSIN 676	52.1	76 2	75.2
PIONEER 322	49 2	82 6	80.3
Pioneer 3314	56 2		
Pioneer 315	48 9	84 2	
PIONEER 349	56 5	83 1	79.7
Hoosiercrost 405	45 7	73 7	
INDIANA 416	55 2	83 4	86.6
Indiana 610	57.8		
Bender 34R	49.8	84 0	
Iowealth AB	49.2	74.8	
Wisconsin 690	55 2		
Indiana 420	53 7		
Indiana 425	51 4		
Kingscrost KY	41.0		
Hoosiercrost 422	54 3	83 2	
Bender 14	43 5		
Iowealth B	45.4	77 5	
National 116	45 4		
Hoosiercrost 461	42 2	75 3	
Hoosiercrost 668	58 7		
Red Cob Ensilage	34.3		

Planting dates: 1938—May 12
1939—May 17
1940—May 21

Harvest dates: 1938—Oct. 11
1939—Oct. 2
1940—Oct. 10

to the acre were produced. In 1940 the trials were in a much less productive field but comparisons were satisfactory. A killing frost occurred September 26 in 1940. At harvest time, two weeks later, all but one of the varieties in the two latest groups still contained 40% moisture or more. It was of interest to the authors that the later varieties were at a yield disadvantage in 1940, the average for the earliest group being 51.2 bushels an acre, for the intermediate group, 51.8 bushels an acre and for the latest two groups 47.1 bushels an acre. The highest yield in 1940 in the St. Joseph trials was obtained with Ohio K-23, a hybrid amply early for this area. This hybrid has also shown to advantage in the Monroe and Ingham county trials on a three-year basis.

Table 3. Yields of varieties tested in Ingham County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Michigan 71A...	45 1		
Minnesota 401	58.4		
Michigan (Exp 70233)	64 1		
Kingscrost KN121	61 6		
Iowealth W-16	56 2	64.6	
Wisconsin 355	51 1		
Minnesota 600	57.5		
Iowealth W-12	54 3		
MICHIGAN 1218	52.7	63 1	59.2
Wisconsin 460	59 1		
Kingscrost KN5	65 7		
KINGSCROST D	64 8	66 7	63.5
WISCONSIN 531	56 5	66 0	61.7
PICKETT O.P.	47 6	55.6	52.1
PIONEER 355	67 3	71 2	64.7
Kingscrost KN2	70 2		
Ohio M-15	77.5	75 4	
OHIO K-23	74.6	73 1	65.6
WISCONSIN 525	57 2	60 8	58.3
DUNCAN, O.P.	52 4	55.2	54.5
IOWEALTH 95	67 6	72 4	64.2
KINGSCROST FK	77 2	73 3	67.6
FUNKS' G-7	69 2	71 8	70.8
DeKalb 240	65.4	67 9	
Minnesota 403	62 2		
Pioneer 353	74 9		
WISCONSIN 645	59 7	69.3	66.1
DeKalb 204	65.7		
DeKalb 404A	69.5	72.2	
Michigan 21A	65.7		
Funks' G-18	71.1		
PIONEER 322	80.0	78.2	71.2
Pioneer 3330	68.9		
DeKalb 225	63.2	70.1	
Iowealth AB	68.9	71.7	

Planting dates: 1938—May 11
 1939—May 12
 1940—May 11

Harvest dates: 1938—Oct. 20
 1939—Oct. 4
 1940—Oct. 4

INGHAM COUNTY

The Ingham county trials, conducted for the last three years on the Michigan State College farm at East Lansing, have been favored by good soil and early planting. A full crop of soybeans was plowed under for the 1940 crop, furnishing an abundance of organic matter. Hybrids as early as, or earlier than, Michigan 1218 have been earlier than necessary for these circumstances although an excellent yield was obtained in 1940 with an experimental Michigan hybrid, No. 70233.

Ohio M-15, according to Michigan observations and reports from the Ohio Experiment Station is slightly earlier than Ohio K-23 and has given very satisfactory yields for two years in the East Lansing trials. Kingscrot D, Pioneer 355 and Wisconsin 531 appear early enough for late May plantings at East Lansing and each has done well for three years. Hybrids as late as Wisconsin 645 may be a little too late in Ingham county unless seasonal conditions are unusually favorable while still later hybrids, though weighing up well, were not fully mature and in some of the later plantings at this station were very soft in 1940.

Table 4. Yields of varieties tested in Saginaw County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Wisconsin 279.....	39.4		
Michigan 71A.....	34.0		
Minnesota 401.....	43.7		
Wisconsin 355.....	49.0	51.6	
Wisconsin 330.....	38.9		
Michigan (Exp. 70233).....	57.9		
Kingscrot D4.....	47.5	53.8	
Kingscrot KN5.....	55.1		
Minnesota 600.....	49.3		
DeKalb 78.....	53.1		
MICHIGAN 1218.....	47.8	54.5	58.1
Wisconsin 460.....	48.8		
KINGSCROST D.....	53.1	55.7	60.9
Kingscrot KN2.....	47.2		
PICKETT, O.P.....	42.0	50.4	54.1
Iowaleth 98.....	55.9	61.4	
DeKalb 201.....	53.6	62.0	
WISCONSIN 531.....	52.6	55.9	63.0
Pioneer 355.....	59.2		
Ohio M-15.....	63.2		
Pioneer 370.....	65.8		
WISCONSIN 525.....	47.2	53.3	58.8
Iowaleth 95.....	55.4	59.6	
Michigan 21A.....	64.3		
Pioneer 353.....	61.2		
Pioneer 357.....	62.7		
DeKalb 225.....	54.1	65.0	

Planting dates: 1938—May 17
1939—May 18
1940—May 15

Harvest dates: 1938—Oct. 6
1939—Sept. 26
1940—Sept. 26

SAGINAW COUNTY

The Saginaw county trials were conducted on the Herbert Schmeige farm near Chesaning. The European corn borer infestation was bad in this trial but, fortunately, there were no high winds to break the corn over. Plants were found with as many as 50 borers and these fell over with a light push. The earlier varieties in particular suffered in yield from borer infestation.

Wisconsin 531 leads this trial on the basis of three-year averages while Michigan 1218, somewhat earlier, has a very good three-year record. It is doubtful whether any hybrids later than Ohio M-15 should be used in this area and even this hybrid may require favorable conditions to reach full maturity.

HURON COUNTY

The Huron county trials were plagued by a severe hailstorm in 1939 and very severe European corn borer damage in 1940. Conducted on the Herbert Gettel farm north of Pigeon, the soil conditions have

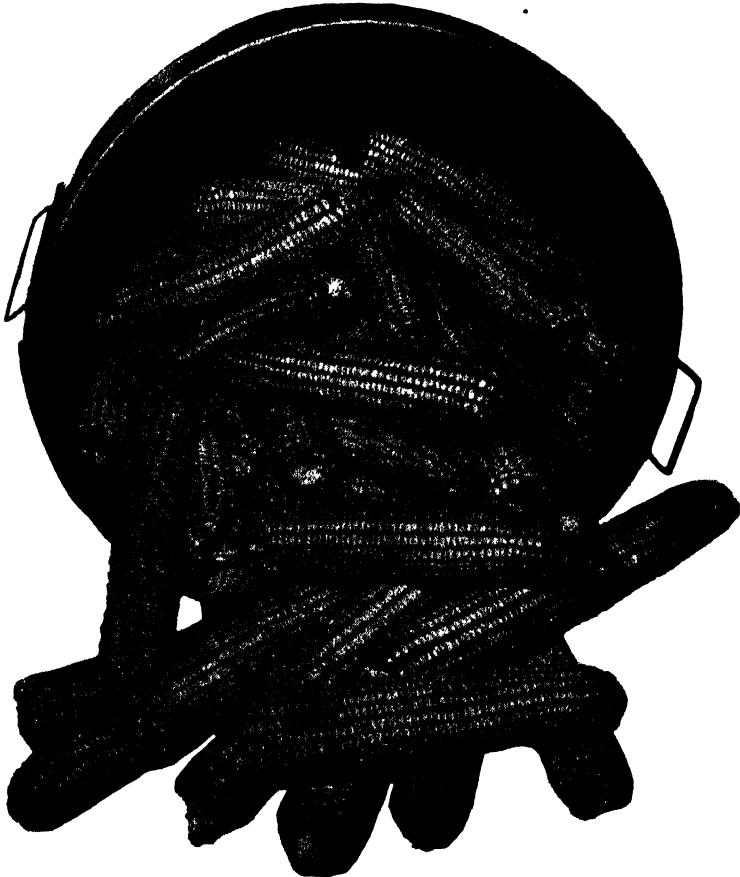


Fig. 2. Michigan Hybrid No. 1218.

been excellent. The corn yields were much below the potential productivity of this soil in both the last two seasons. In 1940 as many as 90% of the stalks of some plats were broken by borer damage. There was no consistent varietal advantages in this respect.

Wisconsin 355 seems earlier than necessary for some conditions in this locality, and about right for late May planting or growth on the less fertile soils. Michigan 1218 did poorly in 1940 but has been one of the better hybrids for this location in other years. Its chief disadvantage is in strength of stalk, being more comparable with Pickett corn in this respect. It has consistently out-yielded the Pickett variety. A Pioneer hybrid, No. 3370, showed considerable promise in 1940.

Table 5. Yields of varieties tested in Huron County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Wisconsin 279.....	37.5		
Wisconsin 275.....	37.1		
Michigan 71A.....	29.5		
Kingsroast A3.....	37.5	38.8	
Kingsroast D4.....	41.6	45.6	
Kingsroast 108.....	40.3		
Wisconsin 330.....	32.4		
WISCONSIN 355.....	34.0	34.4	45.8
Minnesota 401.....	41.6		
Minnesota 600.....	39.7		
Michigan (70233).....	41.9		
Kingsroast D.....	46.0		
PICKETT, O.P.....	30.8	33.8	45.7
MICHIGAN 1218.....	31.8	35.5	49.4
Pioneer 3370.....	57.5		
WISCONSIN 531.....	40.0	40.6	52.0
Pioneer 355.....	46.7		
Ohio M-15.....	54.3		
Iowearth 95.....	53.7		
Michigan 21A.....	42.9		
Pioneer 357.....	40.6		
DeKalb 201.....	41.6	42.1	
Iowearth 98.....	41.6	48.9	
DeKalb 240.....	44.5		

Planting dates: 1938—May 18
1939—May 22
1940—May 18

Harvest dates: 1938—Oct. 4
1939—Oct. 12
1940—Oct. 3

NORTHERN MICHIGAN

Results of trials in Wexford and Otsego counties have been comparable. These have been conducted on the farms of William Franke, Tustin, in Wexford county and Tom Millbocker in Otsego county.

None of the corns tested has been able to mature consistently at either of these locations, the three-year average moisture content at

Table 6. Yields of varieties tested in Wexford County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Kingscroat 125.....	40.0		
NORTHWESTERN DENT, O.P.....	27.0	38.9	31.7
KINGSCROST E.....	36.2	45.7	37.9
Wisconsin 279.....	38.4		
MINNESOTA 402.....	39.1	49.6	39.4
Wisconsin 275.....	40.0		
Wisconsin No. 25, O.P.....	42.9		
Michigan 71A.....	37.8		
Minnesota 401.....	43.2		
Wisconsin 330.....	34.3		
Kingscroat A3.....	45.1		
Wisconsin 355.....	42.5	53.9	
DeKalb 66.....	36.5		
Michigan (Exp. 70233).....	39.1		
Iowaleth 91.....	34.9	50.6	
Iowaleth W-16.....	37.5		
MICHIGAN 1218.....	40.0	50.4	42.1
Pioneer 355.....	35.2		
DeKalb 201.....	38.1	53.9	
Pioneer 357.....	35.6		
Michigan 21A.....	25.7		
Pioneer 3370.....	26.0		

Planting dates: 1938—May 23
 1939—May 19
 1940—May 14

Harvest dates: 1938—Oct. 13
 1939—Sept. 20
 1940—Oct. 7

Table 7. Yield of varieties tested in Otsego County.

Variety	Yield (Bushels per Acre)		
	1940 only	1939-40 average	1938-39-40 average
Kingscroat 125.....	40.6		
NORTHWESTERN DENT, O.P.....	30.2	32.4	30.2
MINNESOTA 402.....	43.2	45.0	41.4
Wisconsin 275.....	44.8		
Michigan 71A.....	40.6		
WISCONSIN NO. 25, O.P.....	46.0	47.4	41.5
Kingscroat A-3.....	45.7		
KINGSCROST E.....	38.1	42.2	37.0
Wisconsin 279.....	37.8		
WISCONSIN 355.....	40.0	46.0	42.3
Wisconsin 330.....	43.2		
Michigan (Exp. 70233).....	48.3		
MICHIGAN 1218.....	44.5	44.6	40.3
Iowaleth 91.....	41.0	45.9	
Iowaleth W-16.....	32.1		
Pioneer 355.....	40.6		
Pioneer 3370.....	29.8		
Michigan 21A.....	37.1		
DeKalb 240.....	33.7		

Planting dates: 1938—May 24
 1939—May 20
 1940—May 22

Harvest dates: 1938—Oct. 12
 1939—Oct. 10
 1940—Oct. 8

harvest for each of them being in excess of 40%. Minnesota 402 has been as satisfactory as any in tests which cover a five-year period. Kingscrot E has a very good three-year record and is a pure yellow dent whereas Minnesota 402 is mixed yellow and white. Wisconsin hybrids 275 and 279 appeared promising in 1940 trials and have given excellent results in northern Wisconsin.



Fig. 3. Minnesota Hybrid No. 402.

SUPPLEMENTARY TRIALS

By A. A. JOHNSON

In addition to the seven major over-state corn trials conducted in Michigan, ten supplementary trials were carried on in 1940. In general, varieties were chosen for these trials which had already shown some promise. At each location at least one variety too early for the area and one later than is desirable were included for demonstration purposes.

The plot layout consisted of five blocks in which the varieties were distributed at random. Thus each variety appeared in the test five times. In addition, a check variety was planted every fifth plot to aid in making accurate comparisons.

In the following tables the yield results are reported for each test with varieties listed in order of maturity. Information with respect to relative maturity is based on records in other trials covering a period of years in addition to performance in 1940. Three trials were abandoned because of irregularities in the field.

Lenawee County.

Planting date, May 22	Date harvested, October 17
Variety	Yield (Bushels per Acre)
Wisconsin 531..	63.8
Wisconsin 606.....	70.1
Wisconsin 645.....	72.1
Ohio K-23.....	70.9
Duncan O.P.....	56.2
DeKalb 204.....	66.1
Kingscrot FK.....	68.7
Woodburns, O.P.....	50.1
Michigan 21A.....	61.3
DeKalb 404A.....	79.9
Pioneer 322.....	74.0
Pioneer 349.....	75.1
Funks' G-8.....	71.4
Pfister 368.....	79.5
Ohio W-17.....	81.6
Indiana 416.....	77.1
Pfister 266.....	76.8
Pioneer 307.....	79.3
DeKalb 606.....	83.1
Funks' G-66.....	74.7

The Lenawee County plot was conducted on the farm of Felix Witt, Jasper. The test area was on a uniform, level field, consisting of a clay loam soil. Most of the varieties in this trial were drying satisfactorily by the harvest date, October 17. The moisture content of the ears at harvest of those varieties in the last maturity group was, however, still well in excess of 30%, when the corn should have been dry enough for cribbing. There was a severe infestation of European corn borer in this plot. No varieties showed any inherent resistance

Branch County.

Planting date, May 18		Harvest date, October 11
Variety		Yield (Bushels per Acre)
Michigan 1218.....		48.8
Pickett, O.P.....		46.3
Wisconsin 531.....		52.7
Wisconsin 606.....		58.9
Wisconsin 645.....		62.6
Ohio K-23.....		57.2
Kingscroat F.K.....		61.2
DeKalb 204.....		56.6
Bowens, O.P.....		59.1
Michigan 21A.....		49.8
DeKalb 404A.....		63.3
Pioneer 322.....		61.6
Pfister 368.....		58.2
Indiana 416.....		58.3
Pfister 266.....		54.7

to borer attack. The later maturing varieties escaped severe borer infestation and thus had a higher percentage of erect plants.

The Branch County plot was conducted on the farm of Fred Dunks, Union City. The test plot was located on fairly uniform sandy loam soil. Heavy frosts occurred about Sept. 26, 1940, stopping growth on all varieties in the plot. Varieties in the last two maturity groupings show no yield advantage over those in the second maturity grouping and, as a group, carried a higher moisture percentage in the ears at harvest.

This plot, conducted on the Upjohn-Richland farm, Richland, was located on a uniform, productive clay loam soil. Frosts of September

Kalamazoo County.

Planting date, May 21		Harvest date, October 16
Variety		Yield (Bushels per Acre)
Wisconsin 355.....		63.9
Cornell 29-3.....		65.8
Pickett, O.P.....		61.5
DeKalb 201.....		77.1
Wisconsin 531.....		68.9
Wisconsin 606.....		78.3
Wisconsin 645.....		82.7
Ohio K-23.....		78.8
Kingscroat F.K.....		72.2
DeKalb 202.....		70.5
Michigan 21A.....		66.8
DeKalb 404A.....		80.1
Pioneer 322.....		81.1
Indiana 416.....		89.3
Hoosiercroat 461.....		83.9

26 were less severe in the Kalamazoo County plot than was the case in Branch County. Consequently the later maturing varieties, notably Indiana 416, continued to develop until a more severe frost occurred in the second week of October. On basis of this year's plot, maturity and yields considered, there is little or no advantage in choosing a variety later than from those in the third maturity group.

Jackson County.

Planting date, May 16		Harvest date, October 10	
Variety		Yield (Bushels per Acre)	
Wisconsin 355.....		51.2	
Michigan 1218.....		41.1	
Pickett, O.P.....		42.5	
DeKalb 201.....		51.1	
Wisconsin 531.....		47.8	
Pioneer 355.....		52.0	
Ohio M-15.....		58.0	
Wisconsin 606.....		50.7	
Duncan, O.P.....		35.3	
Wisconsin 645.....		53.6	
Ohio K-23.....		57.5	
DeKalb 204.....		53.1	
Michigan 21A.....		53.7	
Pioneer 322.....		60.7	
Indiana 416.....		61.6	

The Jackson County plot was conducted on the farm of George House, Jackson, with the Jackson County Crop Improvement Association cooperating. The test area was in a slightly rolling field, consisting of a sandy loam soil. Considering both yield and maturity, Ohio M-15 and Ohio K-23 gave the best performance in this plot.

The Montcalm County plot was conducted on the farm of Kenneth Knapp, Coral. This plot was located in a field consisting of a produc-

Montcalm County.

Planting date, May 17		Date harvested, October 7	
Variety		Yield (Bushels per Acre)	
Minnesota 402.....		45.1	
Wisconsin 355.....		49.2	
Michigan 1218.....		51.8	
Pickett, O.P.....		51.1	
Kingacrost D.....		55.6	
DeKalb 201.....		48.5	
Wisconsin 531.....		59.7	
Wisconsin 645.....		55.6	
Pioneer 322.....		49.6	

tive uniform sandy loam soil. Maximum yields of sound corn were obtained from varieties as early as or earlier than Wisconsin 531. The two latest varieties were not mature at harvest time.

Sanilac County.

Planting date, May 23	Date harvested, October 7
Variety	Yield (Bushels per Acre)
Minnesota 402.....	32.3
Kingscroat E.....	26.6
Wisconsin 355.....	32.8
Michigan 1218.....	33.9
Pickett, O.P.....	24.0
Kingscroat D.....	34.3
DeKalb 201.....	39.0
Wisconsin 531.....	36.2
Wisconsin 645.....	40.0
DeKalb 201.....	46.6

The Sanilac County plot was conducted on the farm of Ed Frances, Peck. The ears of all varieties as late as Pickett and later exceeded 40% moisture at the harvest date of October 7. The earlier varieties in this plot suffered in yield from attack by the European corn borer.

Isabella County.

Planting date, May 14	Date harvested, September 23
Variety	Yield (Bushels per Acre)
Minnesota 402.....	32.3
Kingscroat E.....	24.7
Wisconsin 355.....	37.9
Golden Glow, O.P.....	31.1
Michigan 1218.....	30.9
Kingscroat D.....	38.8
DeKalb 201.....	46.5
Wisconsin 531.....	42.4
Wisconsin 645.....	45.4
Michigan 21A.....	38.1

The Isabella County plot was conducted on the farm of Earl Bayes, Shepherd. This plot was located in a level field consisting of clay loam soil. This plot was planted early (May 14) and all varieties earlier than Wisconsin 645 were ripe or nearly so on the harvest date of September 23. There was considerable damage from the European corn borer in this plot.

The Clare County plot was conducted on the farm of Lowell Penrose, Clare. This plot was in a fairly uniform field consisting of loam

Clare County.

Planting date, June 3		Date harvested, October 4
Variety		Yield (Bushels per Acre)
Minnesota 402		38.7
Kingscrot E		28.5
Wisconsin 355		41.6
Golden Glow, O.P.		36.7
Wisconsin 404		42.4
Michigan 1218		35.9
Kingscrot D.		43.4
DeKalb 201		40.3
Wisconsin 531		40.9
Wisconsin 645		40.3

soil. This plot was planted late, June 3, and Minnesota 402 and Kingscrot E were nearest ripe at harvest time. The ears of all other varieties were very immature, containing 50% moisture or more.

Leelanau County.

Planting date, May 23		Date harvested, October 8
Variety		Yield (Bushels per Acre)
Minnesota 402		41.5
Kingscrot E		31.9
Wisconsin 355		48.9
Golden Glow, O.P.		43.1
Michigan 1218		39.6
Kingscrot D.		43.5
DeKalb 201		45.6
Wisconsin 531		40.5
Pioneer 355		40.1
Wisconsin 645		30.8

The Leelanau County plot was conducted on the farm of the Kahrs Bros., Suttons Bay. The test area was located on a rolling productive field. None of the varieties in this plot had attained maturity (40% moisture) at the date on which this plot was harvested.

The Cheboygan County plot was located on the farm of Alex Weiss, Levering. The plot was located on a rolling field consisting of sandy loam soil. None of the varieties in this plot was mature (40% moisture) on the harvest date, October 9.

Cheboygan County.

Planting date, May 24		Date harvested, October 9	
Variety		Yield (Bushels per Acre)	
Northwestern Dent, O.P.		24.6	
Minnesota 402		33.9	
Kingscroat E.		33.4	
Michigan 71A		33.4	
Wisconsin 355		41.3	
Kingscroat A3		32.1	
Golden Glow, O.P.		25.1	

SPRAYS TO CONTROL THE SCOTCH PINE SCALE, *TOUMEYELLA NUMISMATICUM*

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Early in 1940 a heavy infestation of the Scotch pine scale, *Toumeyella numismaticum*, on a large uniform planting of jack pine, presented an ideal set-up for experimental work. The infestation was of about five years standing and affected every tree. Characteristically, the heavy infestation was greatest on the lower branches and from the tips of the twigs back onto the three- and four-year growth.

The stand was divided into 11 plots and sprayed with the combinations indicated in the accompanying tabular presentation. The first 10 plots were of 20 trees each, whereas the eleventh contained approximately 800 trees and served as a check, inasmuch as 4 per cent bordeaux-oil emulsion has been previously reported as controlling *Toumeyella numismaticum*.

1. One gallon oil—vis.* 108 containing 4.6 oz.** DNOCHP†
2. One gallon oil—vis. 108 containing 4.6 oz. DNOCH††
3. One gallon oil—vis. 87 containing 4.6 oz. DNOCHP
4. One gallon oil—vis. 52 containing 4.6 oz. DNOCHP
5. 8 oz. DNOCHP plus 12 oz. lye (94% NaOH)
6. 16 oz. DNOCHP plus 12 oz. lye (94% NaOH)
7. 8 oz. DNOCHP plus 12 oz. lye (94% NaOH)
8. 16 oz. DNOCHP plus 12 oz. lye (94% NaOH)
9. 8 oz. DNOC plus 12 oz. lye (94% NaOH)
10. 16 oz. DNOC plus 12 oz. lye (94% NaOH)
11. 4 gallons oil vis. 108 emulsified with ½-½-100 bordeaux (Check, 800 trees)

The sprays were applied between April 10 and 17. At that time the scales were showing signs of life. A power rig was used which gave 600 pounds pressure at the nozzle. Particular care was exercised to cover the lower branches and tips of the twigs.

*Vis. = Viscosity Saybolt 100° F.

**Indicated amounts added to 100 gallons water.

†DNOCHP = Dinitro-orthocyclohexyl-phenol.

††DNOC = Dinitro cresol.

Spray materials 5-10 inclusive prepared by grinding with bentonite.

To determine the effectiveness of the sprays the trees were checked July 15, 1940. Four branches from 10 trees in each plot were selected at random and all scales were counted on 2-foot lengths of each branch selected. (Branches were selected from the four sides of each tree.)

At the time the checks were made the only live individuals of *Toumeyella numismaticum* to be found were upon occasional branches, obviously missed by the spray. In all instances, the sprays were 100 per cent effective when the scales were hit.

In no instance did any of the sprays cause injury to jack pine, even in instances where the trees were weakened as result of the heavy infestation of *Toumeyella numismaticum*.

A SUGGESTED PROGRAM FOR THE CONTROL OF BOVINE MASTITIS IN MICHIGAN

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The mastitis control program is available to every dairyman of Michigan. There are no rules, regulations, or agreements to sign. It is the responsibility of each dairyman to see that the testing is properly carried out and to see that certain essential sanitary measures are adopted in handling the herd if the program is to accomplish anything in his dairy herd.

The conditions that exist on each dairy farm, peculiar to that individual herd, make it impossible to give an exacting blanket mastitis control program that will apply in each case. For that reason the author recommends that each dairyman consult his local veterinarian. Many veterinarians are equipped to make a microscopic test of milk samples for streptococcic mastitis.

Mastitis vials, containing the differential preservative, for use in submitting milk samples for test can be obtained from Dr. H. H. Ruhland of the Animal Pathology Department of the College. A 2-cent charge is made for each vial. An additional 8 cents is charged for each sample when the milk is submitted for test. This makes a total of 10 cents per cow for testing inasmuch as one composite sample is submitted from each cow.

The Proper Collection of Milk Samples for Test

Milk samples must be properly collected and handled if the test results are to be of any value. Only milk samples from lactating cows can be tested with any degree of accuracy. Strict adherence to the following procedure will yield milk samples satisfactory for testing:

1. **Do not collect samples within a period of two hours after milking**—Approximately 50 per cent of the infected cows give a negative test when samples are collected too soon after milking the animals. Apparently the streptococci in the milk cistern and ducts of the udder

are completely flushed out with the milk, and usually are not replaced by bacteria from the deeper regions of the udder until near the end of the two-hour period.

2. **Wash udders and teats with chlorine solution (200-400 p. p. m.)**—This procedure is important in excluding from the sample the fecal streptococci that are normally present in the manure and that look just like the mastitis streptococci. The chlorine kills the bacteria on the udders and teats wiped, thereby excluding these confusing bacteria from the milk sample to be tested.

3. **Discard the first two streams of milk from each quarter into a strip cup**—This is essential for flushing away any dirt and bacteria that may be on the end of the teat. Failure to discard the fore-milk may introduce contaminating bacteria that will interfere with the accuracy of the microscopic test results.

4. **Collect a 5-cubic centimeter (fill mastitis vial slightly more than half full) cow composite sample by milking directly into the vial containing the differential preservative, being careful not to touch the part of cork that goes into the tube. Label the vial**—If milk is submitted from only three quarters of a cow and a negative test result is obtained the infection in the fourth quarter is missed. This infection causes the fourth quarter to produce less milk and butterfat, milk of abnormal appearance, or may be responsible for that quarter being "blind" or non-functional. A small amount of milk or secretion from each of the four quarters must be included if the test results are accurately to indicate the status of the cow.

5. **The person collecting milk samples must wash his hands in chlorine solution (200-400 p. p. m.) prior to sampling each cow**—This is essential to prevent the contamination of milk samples with bacteria from his own person or bacteria from a previously sampled infected cow.

6. **Fill in all portions of the mastitis report and send it with the milk samples**—This information is essential to interpret accurately the results of the test and thereby arrive at a diagnosis. The "months since calving" and "record of udder injury" aid in determining whether an increase in the leucocyte content of milk is a result of physiological or pathological processes. Any past or present changes in the udder or milk should be recorded, for this information is essential in determining the cause of acute cases of mastitis. Staphylococci, *Escherichia coli* or streptococci may be the causative factor in acute mastitis. If staphylococci and *Esch. coli* are noted on microscopic examination of incubated milk and a history of trouble is recorded, a definite diagnosis can be made of these forms of infectious mastitis.

The Frequency of Testing Cows for Mastitis

The number of times that the herd should be tested will depend on the individual dairy herd. A suggested plan is to test at monthly intervals for three months, every other month for about eight months and at about 90 day intervals thereafter. The tendency is to allow too great an interval of time between tests. This is unfortunate for

not all cows of the herd are lactating at any one time and only milk from lactating cows can be tested with any degree of accuracy, and if infection does gain entrance to the herd, it may spread and do much damage before its presence is detected.

Recommendations for the Prevention and Control of Mastitis

1. **Consult your local veterinarian**—The specific conditions existent on each dairy farm require expert knowledge for the proper application of preventative and control methods of handling the dairy herd.
2. **Test the herd to locate the infected cows**—A physical examination should be made of the udder of each cow and a microscopic test should be made of the milk of each lactating cow of the herd to determine the exact status of every cow. The methods of control to be applied depend, in part, on the number of infected cows in the herd and a consideration of their economic value.
3. **Dispose of the badly infected cows, detected by physical examination, for slaughter**—These cows are not efficient milk producers owing to the scar tissue in the udder. The scar tissue forms in the udder of the infected cow at the expense of secreting tissue and through a replacement process greatly reduces the milk-secreting ability of the cow.
4. **Segregate infected cows, detected by microscopic test, at one end of the milking line or in another stable until they are removed from the herd**—Some of these cows may still be profitable because of the amount of milk they produce but they must be handled as infected cows to prevent further spread of the infection in the herd. Therefore, the sanitary measures suggested in 10 must be practiced at all times.
5. **Upon removal of infected cows from the herd, their stalls must be cleaned**—All manure and dirt must be mechanically removed by scraping, followed by a thorough scrubbing with a lye solution. Superphosphate or lime may be applied to the floor because they exert a marked germicidal action against the bacteria that cause infectious mastitis.
6. **Test all replacement cows before purchase or buy them subject to such test**—(Isolate until tested). It is obvious that only non-infected replacement animals should be added to the herd.
7. **Procedures must be practiced in raising heifer calves to prevent udder injury and to prevent the sucking that breaks the seal on the teats if they are to be used as good replacement cows**—The bacteria that cause infectious mastitis invade the mature or immature udder through the normal teat canal upon repeated exposure or through injuries of the udder or teats. The infection is kept out by the unbroken skin of the udder and the normal unmolested seal of the teat in the heifer.
8. **Stable cows in properly constructed stalls or stanchions with plenty of clean bedding to prevent udder injuries**—The prevention of udder injuries is responsible for removing one avenue for entrance of the infecting bacteria into the udder.

9. All injuries, especially those occurring on the udder and teats, must be properly treated to prevent marked defacement or further complications of the injured part—Veterinary aid should be obtained in the care of udder and teat injuries.

10. Employ the following sanitary measures in the barn at all times :

- a. Before milking, wipe the udder of each cow with a clean cloth moistened with chlorine solution (200 p. p. m.).
- b. Discard the fore milk into a strip cup.
- c. In hand milking, wash hands before milking each cow.
- d. Exclude people with "running sores" on their hands or "strep" throats from the milking of cows.
- e. In machine milking, dip teat cups into two separate pails of chlorine solution (200-400 p. p. m.) before milking each cow.
- f. Do not permit a calf to nurse in the milking line.
- g. Use superphosphate or lime on the pavements and platforms.
- h. Permit plenty of sunshine to enter the barn.
- i. Milk infected cows last and properly dispose of their milk.

The application of these procedures is essential in the prevention and control of mastitis in the dairy herd. In addition, the milk produced under these conditions will be of much higher quality than where these sanitary measures are not employed.

11. Proper preventive vaccination may be of value where the infected cows must remain in the herd for some time—The proper use of vaccines and bacterins can result in no harm but on the other hand only a trial will indicate if any good can come from their use in the individual herd. It is recommended that the dairyman consult his local veterinarian concerning this matter.

To eradicate the disease from the herd it is necessary to eliminate all infected cows, including those not yet in the advanced stages of mastitis.

CARROTS USED FOR GREEN FEED SUBSTITUTE

J. G. WELLS, JR., AND J. A. DAVIDSON
U. P. EXPERIMENT STATION, SECTION OF POULTRY HUSBANDRY

During 1938-39 a comparison of carrots, dehydrated alfalfa leaf meal, and "Greenmelk" a commercial preparation, composed of dehydrated cereal grass and condensed milk by-products, was carried on at the Upper Peninsula Experiment Station. These materials were used principally as a source of carotene, which is essential for the production of vitamin A in the nutrition of the animal. A report of this trial will be found in the February 1940 issue of the *Quarterly Bulletin* of this Station.

In the early part of the trial an unusually large quantity of carrots were consumed, owing to increasing the palatability of the carrots by cooking. At one time the consumption was in excess of 10 pounds per hundred birds per day, which is more than one-third of the quantity of feed usually consumed by 100 birds of the White Leghorn breed. The egg production was lower for the entire period, where carrots were fed. The consumption of carrots to the exclusion of other essential feedstuffs, in sufficient quantities, might explain the lower production. The vitamin A content of the livers from the birds fed carrots was higher than from birds in either the alfalfa-fed or "Greenmelk"-fed pens, and the egg yolks contained a reasonable amount of vitamin A where carrots were fed. Those receiving alfalfa gradually reduced the amount of vitamin A in the yolks. It was thought advisable to carry out a comparison during 1939-40 in which the carrots would not be fed in excess quantities.

The 1939-40 Trial

Three pens of 75 birds each of White Leghorn pullets of the same ages were used. They were fed laying mash, as shown in Table 1. Seven per cent of the mash for one pen was dehydrated alfalfa leaf meal; one of the remaining pens was fed cooked carrots and the third pen was fed "Greenmelk", in addition to the laying mash.

Table 1. Laying mashes.

Ingredient	Carrot-fed pen	Greenmelk-fed pen	Alfalfa-fed pen
Ground barley.....	20	20	20
Wheat bran.....	20	20	20
Flour middlings.....	20	20	20
Ground oats.....	12	12	10
Dehydrated alfalfa leaf meal.....			7
Meat scraps.....	8	8	7
Soybean oil meal.....	5	5	5
Dried skimmilk.....	5	5	5
Sardine fish meal.....	3	3	3
Steamed bonemeal.....	1	1	1
Oyster shell flour.....	2	2	1
Iodized salt.....	1	1	1
Fish oil (400 D).....	1	1	1

Whole oats and oyster shell was fed *ad lib.* Gravel was used as grit. A grain mixture of 60 pounds wheat and 40 pounds barley was also fed *ad lib.* in open feeders.

Preparation of Carrots—The carrots used were Chantenay yellow. They were weighed before cooking; generally they were steamed 15 minutes in water by introducing live steam. When steam was not available they were cooked in water just below the boiling point. This treatment softened them sufficiently to increase their palatability and they were readily consumed by the birds. They were fed on top of the dry mash at 11:30 a. m. daily.

"Greenmelk" Preparation—This product was fed at approximately two pounds per 100 birds per day. The "Greenmelk" was diluted, slightly, with water and fed on top of the dry mash at 11:30 a. m. daily.

Results

Feed consumption by the different pens over the six-month period is shown in Table 2. The carrot-fed birds ate approximately the same amount of other feed as the alfalfa-fed pen. The carrots were taken as additional feed.

Table 2. Average feed consumption per bird in pounds.

Month	Carrots					Greenmelk					Alfalfa (dehydrated)			
	Mash	Grain	Oats	Shell	Carrots	Mash	Grain	Oats	Shell	Greenmelk	Mash	Grain	Oats	Shell
November . .	1.80	3.74	1.03	.31	1.40	2.27	4.40	1.10	.20	.57	1.98	3.74	1.15	.20
December . .	3.08	3.85	1.37	.23	1.60	2.52	5.10	1.29	.34	.64	2.49	4.32	1.37	.27
January . . .	3.15	4.27	1.50	.42	1.64	2.96	4.87	1.87	.43	.67	2.32	4.34	1.75	.42
February . . .	2.82	4.48	.91	.22	1.63	2.65	4.63	1.52	.24	.66	2.01	4.47	1.17	.27
March	3.34	4.57	1.05	.43	1.60	3.32	4.95	1.55	.48	.69	2.85	4.55	1.65	.51
April	2.75	4.26	1.56	.50	1.54	2.73	4.78	1.29	.49	.68	2.57	4.61	1.36	.49
Total	16.94	25.17	7.42	2.11	9.41	16.45	28.73	8.62	2.18	3.91	14.22	26.03	8.45	2.16

Table 3 shows the number of eggs produced, the percentage egg production on a hen-day basis and the number of birds dying each month. The egg production of the "Greenmelk"-fed pen and the carrot-fed pen was approximately the same with both pens producing more eggs than those receiving alfalfa. Each bird in the alfalfa-fed pen received about 1 pound of alfalfa during the period, compared with 9.41 pounds of carrots and 3.91 pounds of "Greenmelk". On a dry basis the amount of carrots or "Greenmelk" consumed was about equal to that of alfalfa. The cost of feeding the "Greenmelk" was higher than either the carrots or the alfalfa.

Table 3. Egg production hen-day and mortality.

Month	Carrot-fed			Greenmelk-fed			Alfalfa-fed		
	Number eggs	Per cent production	Number died	Number eggs	Per cent production	Number died	Number eggs	Per cent production	Number died
November	1091	48.5	1	1099	49.7	2	992	44.2	1
December	1279	56.6	2	1396	62.0	1	1126	49.7	1
January	1398	63.6	3	1335	61.8	4	1293	58.3	5
February	1148	59.4	2	1140	59.8	6	1119	57.8	3
March	1157	63.8	0	1119	63.7	2	1155	62.8	1
April	990	58.7	4	1017	61.7	2	1071	60.7	4
Total	7063	58.3	12	7106	59.6	17	6756	56.6	15

The mortality was nearly the same for all pens, with the fewest losses occurring in the pen being fed carrots. On a percentage basis,

the losses were 16 per cent, 22.5 per cent, and 20 per cent on the carrots, "Greenmelk", and alfalfa, respectively.

The trial ended April 30 owing to difficulty in keeping the carrots in good condition for a longer time.

It should be noted that yellow corn was not used in these rations.

Vitamin A Storage of Livers and Vitamin A Content of Eggs—

The vitamin A content of the eggs was determined at monthly intervals by the Chemistry Department under the supervision of Dr. C. A. Hoppert. The results are given in Table 4. They are stated in Blue units per gram. One Blue unit is approximately equal to one and one-half U. S. P. units of vitamin A. The carrot-fed pen and "Greenmelk"-fed pen produced eggs which maintained the vitamin A level or increased it slightly, whereas those receiving alfalfa produced eggs with a lower amount of vitamin A at the end of the trial. These results are the average of several eggs.

Table 4. Vitamin content of eggs—averages of 6 eggs (Blue units per gram).

Month received	Carrot-fed	Greenmelk-fed	Alfalfa-fed
January.....	16.6	15.0	12.6
February.....	16.8	16.0	15.4
March.....	14.3	13.4	14.0
April.....	19.7	16.2	15.5
May.....	20.6	18.2	11.6

The average liver storage of vitamin A was 1520 Blue units per gram for the carrot-fed pen, 626 Blue units for the "Greenmelk"-fed pen and 531 Blue units for those receiving alfalfa. These results were obtained from a composite sample from the livers of four birds from each pen.

Summary

Chantenay yellow carrots may be used as a source of carotene (vitamin A precursor). Presumably any other variety of yellow carrots would give similar results.

The carrots should be cooked without boiling or steamed by use of steam in water to maintain the carotene content.

Eggs from the pen receiving the amount of carrots fed in this trial contained more vitamin A than those receiving "Greenmelk" or alfalfa leaf meal (dehydrated) in the amounts that usually are fed.

When yellow carrots are available and alfalfa products of good quality are not available the carrots may be used as a source of green feed. It should be remembered, however, that good quality alfalfa contains other essential ingredients in the poultry ration.

ROOT AND BUTT ROT IN THE PINETUM AT MICHIGAN STATE COLLEGE

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SECTION OF BOTANY

On Nov. 11, 1940, a severe windstorm caused considerable blowing down of trees throughout portions of the upper and lower peninsulas of Michigan. Twelve white pine trees in the pinetum at East Lansing set out by Dr. W. J. Beal in 1896 were partially or completely blown down. According to Chittenden (2) this 44-year-old white pine plantation, the oldest in the state, covers an area of about $3\frac{1}{2}$ acres and is located on sandy and gravelly soil.

The startling feature of this particular blow-down of trees in the pinetum was the revelation of the extent and spread of injury caused by the velvet-topped fungus, *Polyporus schweinitzii*, which attacks the roots and basal portions of coniferous trees, producing a brown charcoal-like decay or rot of the heartwood.

The presence of this root-rotting fungus in the pinetum was first discovered in 1928 by Dr. D. V. Baxter (1) who has found it to be causing considerable damage in white pine plantations located on unfavorable sites or on sites



Fig. 1. Showing extent of decay by *Polyporus schweinitzii* up into trunk of Number 2 tree (see map.) Breaking and splintering extended from three to eight feet above the ground level.

which have become unfavorable through change of the water table or other environmental factors, since such plantations have been started.

Of the trees affected, four broke off from 6 inches to 3 feet above the ground level (Fig. 1). The breaking resulted from the weakening of the trunk structure by the advanced stages of decay which extended from the roots up into the heartwood of the trunks of these trees. In one case the heartwood was severely decayed to a height of more than 10 feet from the ground level. The trees which broke off were of the same diameter as those which remained standing. The average diameter, breast high, of trees in this plantation is from 10 to 12 inches. Five trees blew down by the breaking off of some roots and the uprooting of the main root system (Fig. 2). In such cases several of the main roots had been rotted and weakened by the action of the fungus, thus reducing the anchorage strength of the root system sufficiently so that the trees could not withstand the wind pressure of the storm.

One tree was blown down on the extreme western edge of the stand. It has been found that some of the roots of this tree were also rotted by this pathogen. In the northern portion of the stand two trees were tipped slightly with loosening and cracking of the soil 3 to 4 feet from and around their bases, indicating that roots were possibly broken. Since both trees are located in an area where the root rot fungus is known to be present, it is possible that they are also infected.

Since the date of its discovery, this fungus and its spread have been observed each year by the appearance of the typical dark ochre-colored, velvet-topped sporophores or fruiting bodies (Fig. 3). The fruiting bodies develop in the duff of the forest floor, usually near to trunks of affected trees. Prior

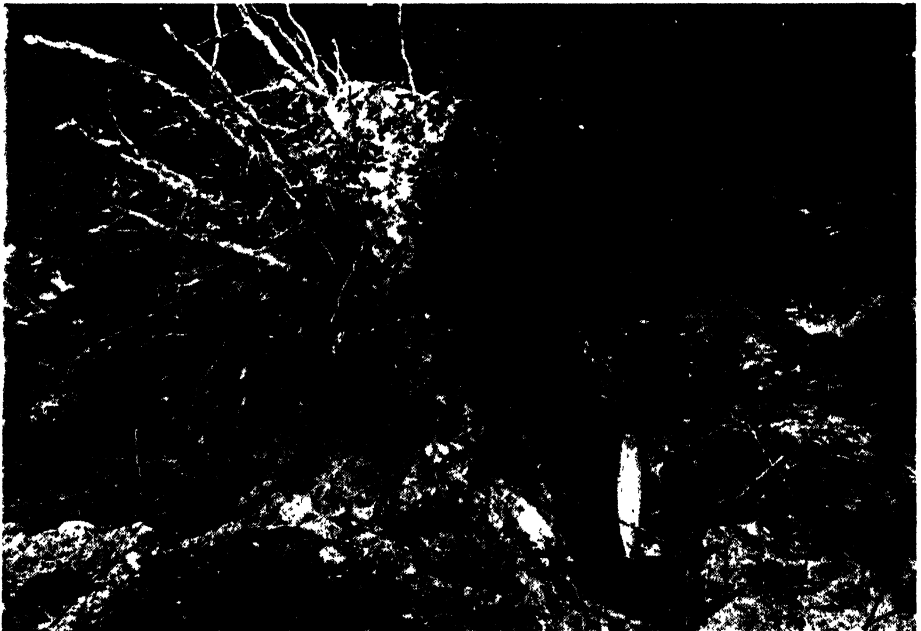


Fig. 2. Example of uprooted tree. Roots decayed extensively but rot has not yet progressed into trunk.

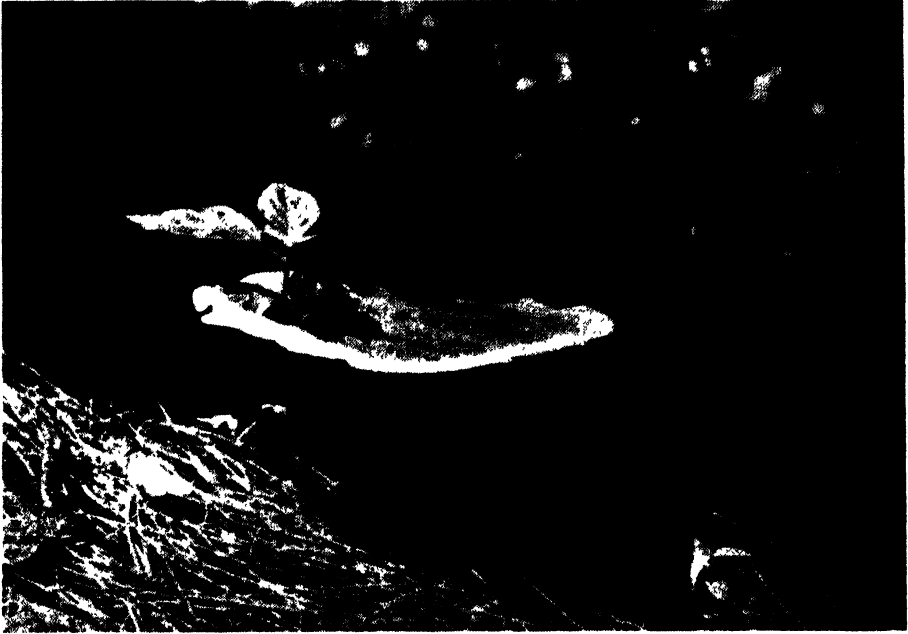


Fig. 3. Fruiting body or sporophore of *Polyporus schweinitzii*, partly obscured by a weed.

to the recent windstorm, only one tree has been known to have blown down as the result of attack by this fungus. However some stumps left from the thinning of 1925 show evidence of decay by this fungus. Inasmuch as Chittenden states that the trees cut at that time were virtually all sound, one must conclude that this decay has developed subsequently.

The number of trees blown down brings sharp attention to the devastating effects of this root and butt rot disease. The rapidity of its spread and injury in the 12-year period since the discovery of the disease leads to speculation concerning the time when all of the pines in this stand will be attacked and succumb.

Mapping of the area (Fig. 4) where the majority of trees were felled by the wind shows very clearly that this fungus has spread from an affected tree to adjacent trees rather than appearing sporadically here and there in the plantation. The tree blown down in 1930 showed many roots rotted, and decay had extended several feet up into the trunk. This tree was located approximately in the center of the area of most severe damage, and the four trees most extensively rotted were nearest to the location of the tree first affected.

It is possible that the stumps of the thinning in 1925 may have served as receptors of spores for the entry of the root rot fungus into this stand. It is recalled that collections of fruiting bodies of the fungus have been made from a Norway spruce stump located on the college campus, from a larch stump in the northern edge of East Lansing, and from a white pine stump located on the college farm. The proximity of these root rot fungus foci indicate the possible presence of others, some of which could conceivably have furnished

spore material to start development in pinetum trees. Once established in the roots of a dead or living tree, this pathogen can make progress from tree to tree by contact or fusion of roots resulting from the close placement of the pine trees. Infection of living trees may have occurred by the germination of the spores of the fungus in the duff on the forest floor and eventual contact of the mycelium with roots. The exact manner in which the infection under consideration occurred is not known.

York (4) indicates from studies of white pine plantations in New York that planted trees develop more soil pockets under the root crown owing to the manner of planting of the trees. Hurried plantings of trees brings about a crossing and often twisting of the roots which later, when these roots have grown larger, bring about fusion of roots with each other and the production of these pockets. The bark surrounding such pockets is thin and the soil inclosed may have root-rotting fungi present which can easily penetrate the wood.

From the information at hand, it would seem that greater care should be exercised in selection of favorable sites for the planting of white pine to avoid stagnation of growth of the trees when they reach an age of 20 or more years. Stagnation of growth and reduction of annual increment may be and probably is favorable for the growth of the root decay fungus. Thinning of the stand under consideration to encourage undiminished growth has been urged by the foresters of this institution but has been met with strong adverse public sentiment for this particular stand. Greater care in planting the trees may in the long run be advisable to avoid production of soil-filled pockets through which root infections can occur.

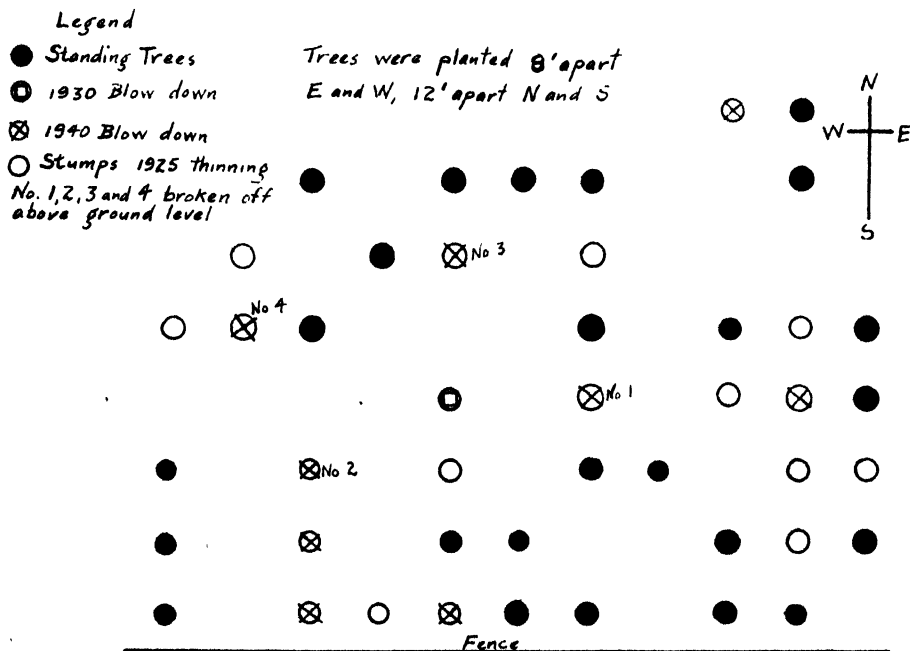


Fig. 4. Map of principal blowdown area, showing spread of *Polyporus schweinitzii* infection.

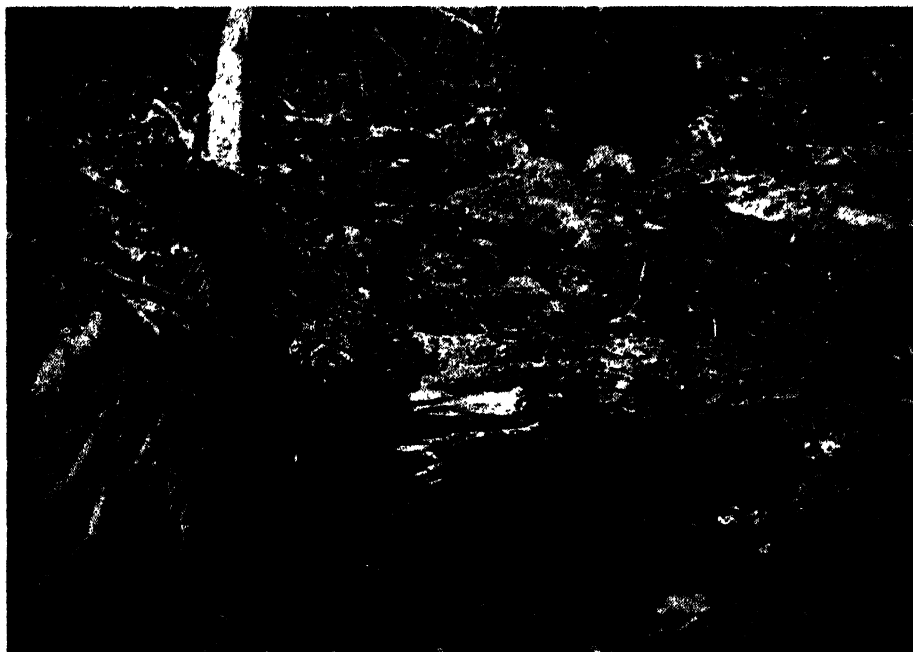


Fig. 5. Illustrating partial breaking off at ground level and uprooting.

The question has arisen whether this disease in this or other white pine stands can be eradicated after once becoming so well established. From a silvicultural standpoint the improvement of vigor of the stand by thinning or fertilization would discourage the spread of the pathogen to still healthy trees. From the standpoint of actual eradication of the diseased trees and eradication of the fungus, it seems very certain that no economically feasible method is known. From a recreational and esthetic viewpoint it may be advisable to attempt control by actual removal of all affected trees, and sterilization of the soil with carbon disulphide in the manner worked out by Hewitt (3) in California where *Armillaria* root rot has become established in citrus groves.

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A CONVEYOR FOR HANDLING POTATOES

TIME IS SAVED—QUALITY IMPROVED

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SECTIONS OF FARM CROPS AND AGRICULTURAL ENGINEERING

Michigan potato growers harvest annually from 20–25 million bushels of potatoes, perhaps one-half of which are stored either on the farm or in central warehouses. Each year from 10–15 per cent of these potatoes are lost, owing to improper methods of handling and storing. A loss of from 3–4 per cent may be expected from natural loss of moisture, but greater losses are often the result of bruises or major mechanical injuries received in handling. This increases the evaporation of moisture and causes excess rotting, a large part of which can be avoided.

One method of handling potatoes to save time and reduce mechanical injury is the use of a belt conveyor similar to the one shown in Fig. 1. This conveyor will handle up to 500 bushels of bulk potatoes per hour from truck or wagon into storage bin at a total cost of about two cents for electricity.

The loss, in storage, of potatoes handled by this conveyor as compared to losses from other methods is shown in Table 1.



Fig. 1. A conveyor for handling potatoes or other farm produce, similar to the one illustrated here, may be constructed for approximately \$100.

Table 1. Comparison of potato losses with methods of handling.

Method of Handling	Shrinkage	No. 1
	per cent	per cent
With elevator.....	6.5	82
*Dump from sacks into bin.....	6.6	80
Picked and stored in boxes.....	4.3	90
Estimated average shrinkage for state.....	8-10	75

*When potatoes are piled too high to dump directly from sacks (or crates) padded planks are laid over bin to reduce injury when walking over potatoes.

Although the shrinkage loss in potatoes handled with an elevator is only slightly less than in potatoes carefully handled by other methods, considerable time is saved by using the elevator. In one instance, four men handling crates were required to handle the same volume of potatoes that two men could handle with the elevator. It seems reasonable to conclude that the labor of at least one man might be saved by using an elevator.

Another distinct advantage of the elevator is the amount of dirt which is removed by the slatted bottom hopper. Approximately $1\frac{1}{2}$ pounds of dirt per bushel were removed in handling one lot of 65 bushels of potatoes. Dirt ordinarily carried in with potatoes is a constant source of trouble; it fills the space between potatoes, interfering with circulation of air and also accumulates moisture and provides an ideal place for the growth of fungi. This is particularly objectionable in wet years, such as this, 1940, when late blight is prevalent.

The potato elevator itself is composed of a belt conveyor, a hopper, and a carriage which regulates the height of the belt and makes the unit portable. The belt is one of the most important items and if purchased new may represent the major item of expense. The elevator shown here uses a part of a rubber belt salvaged from a large industrial plant where such belts are frequently discarded. It is a 16-inch, 3-ply (one rubber and two canvas) vulcanized belt 28 feet long. The expense of a new belt of similar type would hardly be justified. For a new belt it is suggested that a 2-ply 16-inch canvas belt be obtained at a cost of approximately 50¢ a lineal foot.

The maximum length of conveyor seems to be about 16 feet if it is to be driven from a motor mounted on the lower end, as the one illustrated here. The belt is tightened by an adjustable 4-inch roller at the top end and travels at the rate of about 120 feet per minute, using a 4-inch roller at the bottom. The 4-inch steel roller is wrapped with rubber belting to provide additional friction which is desirable to prevent the conveyor belt from slipping.

To overcome any tendency of the potatoes to roll backwards on the conveyor, particularly at steep angles, 15-inch lengths of one-inch garden hose are attached to the belt from 12 inches to 15 inches apart.

The sides of the conveyor are made of 2-inch by 6-inch material bolted together with bolts placed inside of one-inch pipe spaces. Large washers are used at each end of the pipe to provide greater bearing surface. The bed of the conveyor supporting the belt is made of two 1-inch by 8-inch boards sloping toward the middle and resting on the pipe spaces. It may be desirable when elevating at steep angles to at-



Fig. 2. Details of potato elevator.

tach 4-inch sideboards approximately 8 feet long at the lower end of the elevator to prevent potatoes from rolling from the conveyor.

The sides of the conveyor are hinged in the center so that the upper half may be folded back over the lower half for convenience in loading onto a truck for transportation and to reduce space required for storage.

The conveyor is attached at the lower end to the carriage and pivots from this point. It moves freely through the upright and is raised or lowered by a winch. The carriage is mounted on heavy casters for convenience in moving it from bin to bin or for moving from one side of a bin to the other as the bin is being filled. This carriage permits the belt to be raised about 9 feet from the floor, which is adequate for most Michigan storages.

The carriage might be eliminated for some purposes and the construction thereby simplified. In that case, the upper end of the conveyor would be supported in some other manner, depending upon where the conveyor is to be used. For use on the inside of a storage house the upper end could be supported from a wire or track suspended from the ceiling.

A removable hopper is attached to the lower end of the conveyor into which bulk potatoes are dumped from wagon or truck. The hopper has a slatted bottom made by placing rubber-covered $\frac{3}{8}$ -inch iron rods about $\frac{1}{2}$ -inch apart, to prevent injury to the potatoes as they are being handled. Old garden hose may also be used for this purpose.

This hopper may be removed for handling sacked potatoes from a storage house into trucks or directly into freight cars for shipment. Approximately 150 one hundred-pound sacks may be loaded per hour. The elevator shown is equipped with a $\frac{1}{2}$ -horsepower motor, but for handling sacked potatoes a $\frac{3}{4}$ -horsepower motor is more desirable.

In addition to saving labor and reducing injury in handling potatoes this elevator may be used for ear corn, small grain, or other similar purposes on many farms in Michigan.

PRUNING MATURE KIEFFER PEAR TREES

STANLEY JOHNSTON
SECTION OF HORTICULTURE

Until recent years, the Kieffer pear was considered a liability on many fruit farms rather than an asset. Then commercial canners learned how to prepare a very good canned product from this variety and the demand for it since has been sufficient to use all supplies at reasonably good prices.

The Kieffer pear has a tendency to set very heavily in certain years and has acquired a biennial bearing habit to some extent on this account. In years of heavy production, a high percentage of the pears is likely to be rather small. This has been a disadvantage because canneries desire pears of medium size and offer a much lower price for those of the $1\frac{3}{4}$ to 2-inch size, sometimes refusing to take them. Growers have doubted the economic value of thinning the fruits of this variety after setting and have depended largely upon pruning to regulate the size of the fruits.

Two widely divergent types of pruning have been used on Kieffer pear trees in Michigan. In some orchards a severe heading-back type of pruning has been used. Other trees have been pruned according to a light thinning-out method in which closely crowded branches and old, weak spurs were removed.

To determine the best method of pruning Kieffer pear trees in full bearing, an experiment was started in the James Hosking orchard near South Haven in 1933. The trees used were 35 years old at the beginning of the experiment



Fig. 1. Three different types of growth found in mature Kieffer pear trees as the result of different pruning methods:

(Left) Type of growth found in trees receiving the thinning method of pruning or no pruning. No moderately vigorous new fruiting wood has been formed. Trees making this kind of growth will produce a high percentage of small pears and will be inclined to bear alternately heavy and light crops.

(Center) Type of growth produced in trees receiving a moderate heading pruning. Note the moderately vigorous new wood with an abundance of strong new fruit spurs.

(Right) Type of growth produced in trees receiving a severe heading back each year. As a result of this method of pruning very vigorous new shoot growth is produced with few fruit spurs being formed. Small yields of very large pears are produced.

and in excellent condition. They had received a moderate type of pruning regularly and had been well fertilized, sprayed and cultivated. Trees for the different pruning treatments were carefully selected so as to have the average tree size in each plot as nearly alike as possible.

The following pruning treatments were used:

Thinning—Branches were thinned where crowding and some very old weak spurs were removed. Because the Kieffer tree is naturally a very open-growing type, the pruning given under this method would be considered light.

Moderate Heading—All branches making less than approximately 6 inches of new terminal growth were headed back into wood two and three years old.

Severe Heading—In the spring of 1938 it was decided that the heading-back that had been used was not severe enough to compare with that used in some Kieffer orchards in the state where all of the new shoots are cut back to 3 or 4 inches in length each year. This type of pruning has sometimes been called "hedge-row pruning". Accordingly, this method of pruning was included and compared with the moderate-heading type in 1939 and 1940.

Unpruned—Unpruned trees were left for checks during the first five years of the experiment, 1933 to 1937, inclusive. Owing to the excellent care the orchard had received previously, the unpruned trees did not show the ill effects of no pruning until the experiment was under way for about three years.

The results of the experiment are presented statistically in Table 1. The pears were graded as harvested and yields in pounds recorded for the various grades. Values were calculated on the basis of prevailing prices paid by the canning factory during the course of the experiment. These were 90 cents per hundredweight for all pears $2\frac{1}{4}$ inches and over in diameter; 60 cents for the same quantity from 2 to $2\frac{1}{4}$ inches in diameter; and 30 cents per hundredweight for pears from $1\frac{3}{4}$ to 2 inches in diameter. For better understanding, the actual yields and values for the plots of 12 trees are also presented on an acreage basis.

At first glance (Table 1, part 1) one might question the value of pruning during the first three years of the experiment (1933-35, inclusive). On an acreage basis, moderate heading showed a gain of only \$10.17 per acre over no pruning, while the thinning type of pruning showed a loss of \$18.54 compared with the trees receiving no pruning. A question might arise as to why the thinning method did not make so good a showing as no pruning. The most plausible explanation seems to be that the thinning of certain branches reduced total production without causing any marked increase in the size of the fruits produced. This is exactly opposite to what took place in the trees receiving the heading-back type of pruning where total yields were reduced but a marked increase in size of the remaining fruits resulted in a greater total value. About 133 bushels (7,308 pounds) less pears were harvested from the trees receiving a moderate heading type of pruning than those which received no pruning to return \$10.17 greater dividends. This would mean a considerable saving in harvesting and handling charges in favor of the moderately headed trees.

Table 1, part 2 shows the ill effects of continued lack of pruning mature Kieffer pear trees, or persistence in using the thinning type of pruning which

do not result in the development of moderately vigorous new producing wood. It will be noticed that the return on an acreage basis from the moderately headed trees was \$62.82 greater per year than from trees receiving no pruning and \$74.16 greater than from trees pruned by the thinning method. The generally lower trend in yields compared with the previous three years (1933-35, inclusive) can be accounted for by a very severe drouth in 1936 which not only reduced the crop that year but also noticeably reduced the 1937 crop.

In 1938 it was decided that the moderate type of heading used was not severe enough to be compared with the "hedge-row" type of pruning used in some Kieffer pear orchards. Accordingly, a new plot was established in the spring of 1938 in which the trees were headed back into wood from two to four years of age. Following this treatment, all new shoots were cut back to about 4 inches in length in the spring of 1939 and again in 1940. Table 1, part 3 shows the results of this type of severe heading as compared to trees receiving the moderate heading type of pruning. The severe heading reduced the value per acre \$65.43, or about 32 per cent.

Observations were made with regard to the amount of time required to prune trees according to the different methods. Severe heading required the

Table 1. Yields and grades of Kieffer pears produced on trees receiving different pruning treatments together with values calculated on the basis of canning factory grades and prices.

(Twelve trees in each treatment)

PART 1. AVERAGE YIELDS PER YEAR FOR THE YEARS 1933-35, INCLUSIVE.

Pruning Treatment	A-Grade 2¼ Inches and Over		B-Grade 2 to 2¼ Inches		C-Grade 1¾ to 2 Inches		Totals - Twelve Trees		Totals on Acreage Basis	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Thinning.....	1,151	\$10.36	1,907	\$11.44	1,242	\$ 3.73	4,300	\$25.53	38,700	\$229.77
Moderate Heading.....	1,930	17.37	1,526	9.16	729	2.19	4,185	28.72	37,065	258.48
Unpruned.....	954	8.59	2,292	13.75	1,751	5.25	4,997	27.59	44,973	248.31

PART 2. AVERAGE YIELDS PER YEAR FOR 1936 AND 1937.

Thinning.....	760	\$ 6.84	1,014	\$ 6.08	1,371	\$ 4.11	3,145	\$17.03	28,305	\$153.27
Moderate Heading.....	1,429	12.86	1,636	9.82	864	2.59	3,929	25.27	35,361	227.43
Unpruned.....	720	6.48	1,195	7.17	1,547	4.64	3,462	18.29	31,158	164.61

PART 3. AVERAGE YIELDS PER YEAR FOR 1939 AND 1940.

Moderate Heading.....	925	\$ 8.33	1,849	\$11.09	1,087	\$ 3.26	3,861	\$22.68	34,749	\$204.12
Severe Heading.....	893	8.04	1,035	6.21	386	1.16	2,314	15.41	20,826	138.69

NOTE:—The prevailing prices for different grades paid by the canning factory during the course of this experiment were: A-grade, 90 cents per hundredweight; B-grade, 60 cents; C-grade, 30 cents.

most time, in addition to reducing the total yield more than any other treatment. Moderate heading required slightly more time than the thinning method. However, this expense in time was more than offset in the increased total value of the crop produced, and the saving in harvesting and handling expenses. The larger pears produced on the moderately headed trees were harvested with less expense and fewer small pears were picked, hauled to the canning factory, and then hauled home again as rejects because of small size.

The results of this experiment indicate that from the standpoint of increased income and as an aid to annual bearing, the moderate heading method seems best suited to Kieffer pear trees in full bearing. It is suggested that this type of pruning be withheld until the trees are in full bearing and beginning to lose some of their early vigor. To use this method on young trees would reduce their size and might result in such a succulent growth as to make them more susceptible to blight. Young pear trees grown under proper conditions will usually be vigorous enough during the first few years to produce fruits of good size without pruning. The danger of rendering Kieffer trees in full bearing more susceptible to blight in the commercial pear-growing districts of Michigan by using the moderate heading method of pruning is not considered to be serious. Care should be used, however, to prevent excessive new growth in pear trees, even those in full bearing. It would be safer to regulate pruning and cultural practices so that new terminal growth in general will not exceed 12 to 14 inches in length in bearing trees.

The best indicator for the grower to use as to the need for pruning mature Kieffer pear trees is the amount of terminal growth that is being made each year. If at least approximately 6 inches of new terminal growth cannot be maintained by cultivation or a satisfactory mulch system plus the use of fertilizer, it is then necessary to resort to the moderate heading type of pruning. In using this method of pruning it should be remembered that not all branches are headed back each year. Only those whose terminal growths are falling below approximately 6 inches should be cut back into wood two or three years old. In addition, it is considered advisable to thin the oldest and weakest spurs. These are not common until the tree becomes rather old and then are usually found in the center of the tree. This method of pruning results in a gradual renewal of moderately vigorous new wood which will maintain maximum yields of pears of first-grade size, provided the trees are otherwise given good care.

THE NUTRITIVE VALUE OF CHICORY TOPS FOR DAIRY CATTLE*

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SECTIONS OF DAIRY HUSBANDRY AND CHEMISTRY

Chicory and chicory tops have not been used extensively as a feed for livestock. Aguirre (1), however, suggested that they could be used as a cattle feed and presented data on the chemical composition of chicory. Donegan

*The authors are indebted to McMorran and Company, Port Huron, Mich., for supplying them with dried chicory tops.

(2) reported that chicory roots made an excellent substitute for oats in the ration of horses. No bad effects were observed from the feeding of chicory and it was thought that it may have exerted a favorable influence on digestion. Up to 10 pounds of chicory per day per horse were consumed readily. The moisture, protein, fat, nitrogen-free extract, and sugar were found to be 13.8, 4.8, 0.85, 69.7, and 4.35 per cent, respectively. The chicory roots contained 87 feed units in comparison with 82 feed units in dried sugar beets. Rather (3) stated that chicory tops are less valuable as a feed for livestock than sugar beet tops and that, to avoid the danger of producing off-flavored milk, milking cows should not be fed chicory tops.

Because Michigan has almost a monopoly in the production of chicory in the United States and because of the paucity of data concerning the feeding value of chicory tops, feeding experiments were conducted with dairy cattle to ascertain the palatability, physiological effects upon the animal, and the coefficients of digestibility of the tops.

Results

The chicory tops used in this investigation were dehydrated. The leaves were well-cured but many of the crowns and stalks were moldy. The composition of the chicory tops is given in Table 1.

Table 1. Chemical Composition of Chicory Tops.

	As fed	Dry basis
	(per cent)	(per cent)
Moisture	17.4	—
Ash	14.9	18.0
Protein	11.8	14.4
Ether extract	1.85	2.24
Nitrogen-free extract	41.5	50.3
Crude fiber	12.6	15.3
Calcium	1.56	1.89
Phosphorus	0.18	0.22
Magnesium	0.60	0.73
Oxalic acid	0.54	0.65

The calcium-phosphorus ratio in the chicory tops was found to be 8.6 to 1.

Metabolism trials were conducted with three dry cows to determine the coefficients of digestibility of the dried tops. Calcium, phosphorus, magnesium and nitrogen balances were also determined on the same cows. The results obtained by these trials are presented in Table 2.

The appetite for dried chicory tops was measured by determining the

Table 2. Digestion Coefficients and Metabolism Data Obtained from Chicory Tops.

Cow No.	Coefficients of Digestibility					Balances (average daily)				
	Dry matter	Crude protein	Ether extract	Crude fiber	Organic matter	N F.E.	Ca	P	Mg	N
	per cent	per cent	per cent	per cent	per cent	per cent	gms.	gms.	gms.	gms.
A-4	63.3	53.8	5.8	59.4	67.6	76.9	-10.8	3.7	7.5	-8.6
D-5	61.9	56.3	2.9	51.5	67.0	77.7	-0.6	1.7	2.3	-10.3
D-9	65.1	55.3	18.7	61.9	69.3	77.8	-3.3	1.0	12.3	4.3
Average	63.4	55.1	9.1	57.6	68.0	77.5	-4.9	2.4	7.4	-4.9

average daily consumption after the cows had become accustomed to eating the tops and then comparing this intake to the average daily consumption of alfalfa hay. The cows consumed about 25 per cent less chicory tops than alfalfa hay; however, one cow ate 30 pounds of tops daily and another cow consumed 35 pounds daily.

The consistency of the feces was determined, and the results indicate that the consumption of chicory tops did not change the consistency significantly from that obtained from cows receiving alfalfa hay. There was a tendency, however, for the feces to be slightly softer.

The effect of chicory tops on milk production was not determined specifically although one cow made an average gain of 4 pounds of 4 per cent fat-corrected milk per day on 9 pounds less of tops than alfalfa hay. This finding needs further confirmation before any definite conclusion can be drawn.

The flavor of the milk was studied by Trout of the Dairy Section who found that the feeding of chicory tops did not alter the flavor of the milk.

Discussion

The chicory tops fed in this investigation were characterized by high ash values, comparable with those of sugar beet tops and immature grasses, but the tops were low in crude fiber in comparison with mature grasses. The chicory tops were high in calcium and magnesium but low in phosphorus.

The high ash and magnesium content of chicory tops might be expected to exert a laxative effect upon the cows but the results of this experiment indicate that the consistency of the feces obtained from chicory tops was not significantly different from feces obtained from cows on an alfalfa ration.

The coefficients of digestibility for dry matter, crude protein, crude fiber, organic matter, and nitrogen-free extract were 63.4, 55.1, 57.6, 68.0, and 77.5 per cent, respectively. The total digestible nutrients content of the chicory tops used in this experiment was 57 pounds per 100 pounds of dry matter. According to Morrison (4) sugar beet tops have 65 pounds of total digestible nutrients per 100 pounds of dry matter. On the dry matter basis, chicory tops are somewhat less valuable than sugar beet tops in the ration of dairy cattle.

Summary

The chemical composition of dried chicory tops has been determined and metabolism trials have been conducted to determine the coefficients of digestibility. The average coefficients for dry matter, crude protein, crude fiber, organic matter, and nitrogen-free extract were found to be 63.4, 55.1, 57.6, 68.0, and 77.5 per cent, respectively. The total digestible nutrients content of the chicory tops was 57 per cent on the dry basis.

The cows consumed about 25 per cent less tops than alfalfa hay. From 30 to 35 pounds of tops were consumed daily per cow.

The feeding of dried chicory tops did not alter the flavor of the milk.

The feeding of dried chicory tops did not have any appreciable effect upon the consistency of the feces.

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HOME-GROWN FARM PRODUCE USED BY THE FARM HOUSEHOLD

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One of the best markets a farmer has for some of the produce raised on the farm is his own household. For home-grown produce used in this way he receives not farm prices but in a sense the equivalent of retail prices. A family, living in the city or even in the country, which has to buy most of these products knows what this means.

A complete record of the amounts and values of home-grown farm products used by the farm household was kept on 268 Michigan farms in 1939. These records were distributed throughout the state and were kept as a part of the regular farm accounting extension project sponsored by the Farm Management Department of Michigan State College and the county agricultural agents in 77 counties. There were 1,496 farm account books summarized in this project but only 268 farmers kept complete records on the home-grown farm produce used by the household, other records being only partial or incomplete.

Farm prices, as estimated by the cooperators in the various parts of the state, instead of retail prices, were used in computing the values of the farm products used by the household. These prices varied greatly between areas and also between farms in the same area. In general the prices averaged about one-half of city retail prices. In addition to the farm produce used by the household the farm family received the use of the house. An annual house rent was figured at 10 per cent of the estimated value of the farm house.

Michigan is large and contains within its boundaries a great variation in conditions. Factors such as soil, climate, topography, markets, transportation facilities, nationality of the people, and many others vary greatly and in turn cause much variation between areas in the amounts and prices of farm products used by the household. Thus, in this report the average figures for the state as a whole are first presented and then for each of three different areas into which the state is divided.

Averages for 268 Michigan Farms

The average value of home-grown farm produce used by the household on the 268 farms in 1939 was \$293.08 and ranged from \$78 to \$761 (see Table 1). The average size of family was 3.3 adults, and 1.6 children under 16 years of age. The house rental charge averaged \$193.80 and ranged from \$19.50 to \$564.00. The combined value of the farm produce and house rental charge amounted to \$486.88 per farm.

In addition to the average amounts and value of farm produce used by all families included in the report, it is also interesting to know what these data amount to for just the families that used the particular items (see Table 1). The 268 households used an average of 29 cords of wood valued

Table 1. The amounts and values (at farm prices) of home-grown farm products used by farm households on 268 Michigan farms during 1939. Average size of family 3.3 adults, and 1.6 children under 16 years of age.

Item	Average per farm for the 268 farms			Average for farms using			
	Amount	Price	Value	Farms		Amount	Value
				No.	Per cent		
Fuel, cords	29	\$1.59	\$ 45.94	228	85	34	\$54.00
Milk, quarts	1,315	.034	44 68	265	99	1,330	45.19
Cream, pints	114	.13	14 54	175	65	175	22 27
Butter, pounds	107	.28	30.11	183	68	157	44.10
Eggs, dozen	141	.19	26 22	243	91	155	28 92
Poultry, pounds	*101	*.16	15 72	232	87	*117	18 16
Beef, pounds	109	.12	13 04	115	43	255	30 38
Pork, pounds	275	.09	24 75	196	73	377	33.84
Mutton, pounds	9	.11	95	26	10	91	9 77
Potatoes, bushel	32	.57	18 43	264	99	33	18 71
Other vegetables	—	—	19 28	†243	91	—	21 26
Fruit	—	—	12 39	206	77	—	16 13
Products canned	—	—	25 08	197	74	—	34 12
Miscellaneous	—	—	1 95	55	21	—	9 49
Average per farm			293.08				
House rent			193 80				

*91 cases estimated

†Undoubtedly all the farms used some fresh vegetables. On account of the small amounts of the different vegetables consumed at any one time, however, and the trouble involved in recording the values of these products a few farms did not report the use of these items.

at \$45.94 per farm. However, there were only 228 households that used wood from the farm, which increased the average to 34 cords of wood valued at \$54.00 per farm using. On some items the lack of comparable quantity units has resulted in showing only average values.

Home-grown Farm Products Used in Southern Michigan

This region includes 161 farms located in counties lying south of a line drawn across the state from the southern boundaries of Arenac County on the east to Mason County on the west. Approximately 60 per cent of the farms included in the study are located in this region.

The average value of home-grown farm produce used by the household on these farms was \$284.61 and ranged from \$78 to \$761 (see Table 2). The average size of family was 3.2 adults, and 1.5 children under 16 years of age. The house rental charge averaged \$220.17 and ranged from \$19.50 to \$564. The combined value of the farm produce and house rental charge amounted to \$504.78 per farm. Table 2 also shows the average amounts and values of farm produce per family using the particular items.

Northern Michigan (Lower Peninsula)

This region includes 69 farms located in the Lower Peninsula counties lying north of a line drawn across the state from the southern boundaries of Arenac County on the east to Mason County on the west. Approximately 26 per cent of the farms included in the study are located in this region.

The average value of home-grown farm produce used by the household on these farms was \$305.36 and ranged from \$79 to \$729 (see Table 3). The average size of family was 3.2 adults, and 2 children under 16 years of

Table 2. The amounts and values (at farm prices) of home-grown farm products used by farm households on 161 southern Michigan farms during 1939. Average size of family 3.2 adults, and 1.5 children under 16 years of age.

Item	Average per farm for the 161 farms			Average for farms using			
	Amount	Price	Value	Farms		Amount	Value
				No.	Per cent		
Fuel, cords	27	\$1.54	\$ 41.55	140	87	31	\$47.79
Milk, quarts.	1,268	.037	47.26	158	98	1,292	48.16
Cream, pints	83	.13	10.99	92	57	146	19.24
Butter, pounds	87	.29	24.91	96	60	146	41.78
Eggs, dozen	159	.18	28.91	149	93	171	31.23
Poultry, pounds....	*113	*.15	17.09	142	88	*128	19.38
Beef, pounds	113	.13	14.18	70	43	260	32.60
Pork, pounds	254	.09	21.77	116	72	353	30.22
Mutton, pounds	9	.11	92	14	9	98	10.57
Potatoes, bushel	31	.59	18.15	159	99	31	18.38
Other vegetables	—	—	20.42	†145	90	—	22.68
Fruit	—	—	12.73	122	76	—	16.80
Products canned	—	—	23.71	111	69	—	34.39
Miscellaneous	—	—	2.02	39	24	—	8.33
Average per farm			284.61				
House rent			220.17				

*58 cases estimated

†See footnote on Table 1

age. The house rental charge averaged \$159.36, and ranged from \$22.50 to \$500. The combined value of the farm produce and house rental charge amounted to \$464.72. Table 3 also shows the average amounts and values of farm produce per family using the particular items.

Table 3. The amounts and values (at farm prices) of home-grown farm products used by farm households on 69 northern Lower Peninsula Michigan farms during 1939. Average size of family 3.2 adults, and 2.0 children under 16 years of age.

Item	Average per farm for the 69 farms			Average for farms using			
	Amount	Price	Value	Farms		Amount	Value
				No.	Per cent		
Fuel, cords	32	\$1.55	\$ 49.29	51	74	43	\$66.69
Milk, quarts	1,132	.030	34.30	69	100	1,132	34.39
Cream, pints	171	.13	21.86	57	83	206	26.46
Butter, pounds	145	.28	40.30	59	86	170	47.14
Eggs, dozen	122	.18	21.98	61	88	138	24.87
Poultry, pounds	*92	*.16	14.80	61	88	*104	16.74
Beef, pounds	106	.11	11.54	27	39	271	29.48
Pork, pounds	342	.09	30.30	56	81	421	37.34
Mutton, pounds	13	.11	1.41	10	14	91	9.70
Potatoes, bushel	34	.48	16.33	67	97	35	16.82
Other vegetables	—	—	19.56	†65	94	—	20.77
Fruit	—	—	12.83	55	80	—	16.09
Products canned	—	—	20.00	55	80	—	36.38
Miscellaneous	—	—	1.77	11	16	—	11.09
Average per farm			305.36				
House rent			159.36				

*24 cases estimated.

†See footnote in Table 1.

Table 4. The amounts and values (at farm prices) of home-grown farm products used by farm households on 38 Upper Peninsula Michigan farms during 1939. Average size of family 3.6 adults, and 1.5 children under 16 years of age.

Item	Average per farm for the 38 farms			Average for farms using			
	Amount	Price	Value	Farms		Amount	Value
				No.	Per cent		
Fuel, cords.....	32	\$1.85	\$58.42	37	97	33	\$60.00
Milk, quarts.....	1,846	.028	52.47	38	100	1,846	52.47
Cream, pints.....	145	.11	16.29	26	68	211	23.81
Butter, pounds.....	124	.27	33.63	28	74	168	45.64
Eggs, dozen.....	101	.22	22.53	33	87	116	25.94
Poultry, pounds.....	*69	*.17	11.55	20	76	*90	15.14
Beef, pounds.....	99	.11	10.95	18	47	210	23.11
Pork, pounds.....	244	.11	27.26	24	63	387	43.17
Mutton, pounds.....	2	.11	.24	2	5	42	4.50
Potatoes, bushel.....	35	.68	23.45	38	100	35	23.45
Other vegetables.....	—	—	13.90	133	87	—	16.00
Fruit.....	—	—	10.18	29	76	—	13.34
Products canned.....	—	—	23.70	31	82	—	29.16
Miscellaneous.....	—	—	1.07	5	13	—	15.00
Average per farm.....			306.63				
House rent.....			144.72				

*9 cases estimated.

†See footnote in Table 1.

Upper Peninsula

This region includes 38 farms located in the Upper Peninsula. This is rather a small number and represents only 14 per cent of the total number

Table 5. The average amounts of farm products used annually by farm households on some account keeping farms in Michigan, for six individual years, and the six-year average.*

Item	1929	1931	1933	1935	1937	1939	6-year** average
Number of records.....	51	284	278	163	255	268	216
Fuel, cords.....	20	25	27	28	24	29	26
Milk, quarts.....	1,204	1,241	1,199	1,263	1,239	1,315	1,244
Cream, pints.....	114	87	113	88	105	114	104
Butter, pounds.....	123	103	99	99	83	107	104
Eggs, dozen.....	137	137	131	116	124	141	131
Poultry, dollars.....	\$ 18 70	\$ 13.06	\$ 11.37	\$ 16.18	\$ 16.38	\$ 15.72	\$ 15.24
Beef, pounds.....	79	101	155	140	134	109	120
Pork, pounds.....	272	228	320	293	269	275	276
Mutton, pounds.....	—	12	10	10	9	9	10
Honey, pounds.....	17	6	—	—	—	—	12
Potatoes, bushels.....	37	32	30	34	31	32	33
Other vegetables, dollars.....	\$ 19.61	\$ 16.51	\$ 15.13	\$ 16.37	\$ 18.49	\$ 19.28	\$ 17.56
Fruit, dollars.....	\$ 22 12	\$†30 80	\$ 11.02	\$ 15.02	\$ 13.24	\$ 12.39	\$ 17.43
Products canned, dollars.....	—	—	\$ 16.87	\$ 21.86	\$ 25.49	\$ 25.08	\$ 22.32
Miscellaneous, dollars.....	\$ 11 31	\$ 1 83	\$ 3.61	\$ 4.98	\$ 2.29	\$ 1.95	\$ 4.33
Total value of products used.....	\$372 47	\$264 02	\$233 53	\$287.28	\$306.13	\$293.08	\$292.75
House rent (10% of value).....	\$203 51	\$216.88	\$204.78	\$179.60	\$187.93	\$193.80	\$197.75

*Farm prices were used for each particular year.

**Each year given equal weight.

†Includes both fresh and canned fruit.

of farms included in this study. However, even this small number provides some interesting information.

The average value of home-grown farm produce used by the household on these farms was \$306.63 and ranged from \$152 to \$659 (see Table 4). This is virtually the same average figure as the one for the northern part of the Lower Peninsula. The average size of family was 3.6 adults, and 1.5 children under 16 years of age. The house rental charge averaged \$144.72 and ranged from \$39.20 to \$351. The combined value of the farm produce and house rental charge amounted to \$451.35. Table 4 also shows the average amounts and values of farm produce per family using the various items.

Variations Between Years

Economic conditions during the last few years have brought about increased interest on the part of many people in the amount of home-grown produce used by farm families. Table 5 makes it possible to compare data showing the amounts of the various products used for some recent years. Prices change from year to year and the values are, therefore, not very significant when comparing different years, but they are the best available for this study.

SOYBEAN OIL MEAL FOR PIGS

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Soybean oil meal has a high feeding value as a protein supplement to grain for all kinds of farm animals. Its relatively low cost in recent years, as compared with other feeds comparable to it in protein content, has resulted in a large increase in its use in this state. Rapid changes in methods of manufacture or extraction of the oil from the beans from which the oil meal is a by-product, have made available for purchase several different soybean oil meals. Three different types were tested by pig feeding trials at the Michigan Agricultural Experiment Station in 1940, both on pasture and in the dry-lot.

Four lots of 10 pigs each were self-fed corn and minerals on excellent alfalfa pasture. In another compartment of the feeder in each lot was placed: tankage in Lot 1, expeller soybean oil meal in Lot 2, raw solvent oil meal in Lot 3 and heat-treated or roasted solvent oil meal in Lot 4. All lots made rapid and economical gains, requiring an average of about 320 pounds of grain and supplement for each 100 pounds of gain. However, Lot 3 consumed slightly more than one-half as much raw solvent soybean oil meal as did either Lot 2 of the expeller meal or Lot 4 of the roasted solvent meal.

In another test 22 pigs were self-fed free-choice shelled corn, minerals and four different soybean oil meals: expeller, raw solvent, roasted solvent and soybean flake. The flake was similar to the raw oil meals, except that part of the fiber was removed, leaving a product higher in protein (48 per cent). The position of the four oil meals was shifted each week so that if the pigs had any preference they must find it in a new place each succeeding week for eight weeks, while their weight increased from an average of 37 pounds

to 97 pounds. They gained 1.1 pounds daily per pig and consumed the following amounts of feed for each 100 pounds of gain:

Corn	190.5 pounds
Minerals	1.5 pounds
Expeller soybean oil meal.....	39.7 pounds
Raw solvent soybean oil meal.....	.7 pound
Roasted solvent soybean oil meal.....	22.7 pounds
Soybean flake	1.5 pounds

This demonstrates conclusively the pigs' preference for the two heat-treated oil meals, expeller and roasted solvent.

Four lots of five pigs each were hand-fed individually in the dry-lot on the same three oil meals used in the first pasture experiment. The basal ration in each lot was the same, consisting of ground corn 80 pounds, ground barley 10 pounds, ground alfalfa 10 pounds, and minerals (equal parts of bonemeal, limestone and salt), 1 pound. Tankage and oil meal were used in the different lots so as to give the same nutritive ratio or proportion of protein. The results are shown in Table 1.

The tests demonstrate that heat-treated soybean oil meal, whether heated in the process of manufacture, like the expeller meal, or subsequently like the roasted solvent meal, is much more palatable to pigs than the raw meal. Experiments at other stations show that cooked or roasted soybeans are superior to the raw beans for pigs.

Both heat-treated soybean oil meals were more efficient and economical to feed pigs than the dry-rendered tankage used in these trials, either on pasture

Table 1. Tankage and Different Soybean Oil Meals.

Feeds used	Tankage 16 lb.	Soybean Oil Meals		
		Expeller 25 lb.	Raw Solvent 22 lb.	Roasted Solvent 22 lb.
Ground corn —80 lb } Ground barley—10 lb } Ground alfalfa—10 lb } Minerals — 1 lb. }	Mixed with above-mentioned supplements			
Average initial weight (lb.)	49	46	49	48
Average final weight (lb.)	201	199	189	197
Average daily gain (lb)	1 19	1 29	92	1 27
Feed per 100 lb. gain (lb.)	368	354	426	343
Feed cost* per 100 lb. gain.	\$5.15	\$4 60	\$5 44	\$4 38

*Prices used: Ground corn and barley: \$1.30; alfalfa: 50 cents; minerals: \$2.00; tankage: \$2.50; and all soybean oil meals: \$1.50 per cwt.

or in the dry-lot. The raw solvent meal gave good results on pasture, but gave much slower and more expensive gains in the dry-lot than either tankage or heat-treated soybean oil meal. If the raw solvent meal had been purchased at half the cost of the other oil meals, it would not have proved so economical in the dry-lot trial. Manufacturers are using heat treatment to overcome the disadvantage of the newer solvent extraction processes which have been widely adopted because they extract more of the oil from soybeans. Judging from these trials, one should avoid the raw white soybean oil meals when purchasing for pig feeding.

HORSE COSTS IN MICHIGAN 1937-39

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The year 1939 was the third and last one for the horse cost study conducted by this section of the Michigan Agricultural Experiment Station. During the year 15 farmers kept horse cost records in cooperation with this section. In 1938 there were also 15 cooperators, and in 1937 21 kept horse records.

The annual costs of maintaining horses on some Michigan farms for the three years, 1937, 1938, and 1939, and the averages of those three years are shown in Table 1. It will be noticed that the annual net cost per horse decreased each succeeding year of the study with an average of \$96 per horse per year. When the latter figure is multiplied by the average number of horses kept on each of the farms where records were kept, it amounts to \$307 for each farm in this project.

Table 1. Annual costs of maintaining horses on some Michigan farms, 1937-39.

Item	1937	1938	1939	Average 1937-39
Number of records.	21	15	15	51
Number of horses per farm	3 4	2 9	3 2	3 2
Average age of horses	11 4	13 3	12 9	12 3
Value per horse beginning of year.	\$138	\$ 97	\$ 93	\$113
Hours worked per horse in year	774	789	732	766
Annual costs per horse:				
Feed	\$ 62	\$ 44	\$ 44	\$ 52
Bedding	5	5	4	5
Man labor	26	24	17	23
Depreciation	16	14	10	14
Interest	7	5	5	6
Barn use	9	6	6	7
Harness expense	3	2	2	2
Miscellaneous	2	2	1	2
Total cost	\$130	\$102	\$ 89	\$111
Manure credit	15	16	14	15
Annual net cost per horse	\$115	\$ 86	\$ 75	\$ 96
Net cost per horse hour (cents) . . .	14 8	10 9	10 3	12 5
Net cost of horse work per farm	\$391	\$219	\$240	\$307

Figure 1 shows the relative importance of various items of cost of keeping horses on these farms for the three-year period 1937-39. Feed costs were 47 per cent of the total, man labor 21 per cent, depreciation 12 per cent, while several smaller items comprise the remainder.

*Dr. K. T. Wright of the Farm Management section inaugurated this study in 1937 and has assisted by giving many valuable suggestions. Members of the Farm Management extension service were in charge of collecting the horse records.

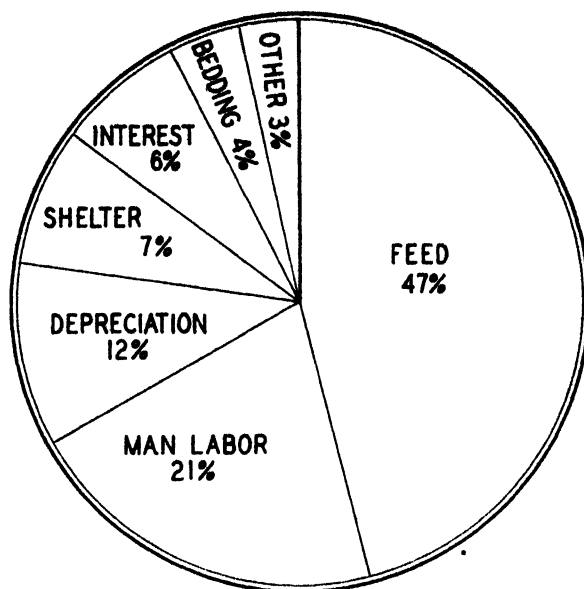


Fig. 1. Distribution of horse costs on some Michigan farms, 1937-39.

The average age of the horses on which records were kept in this study was 12.3 years (Table 2). About 55 per cent of the horses were more than 12 years old.

The total amount of corn and oats fed varied only slightly from year to year although there was some substituting of one for the other. There was a marked indirect relationship between the amount of roughage fed and the price of roughage. The average feed prices and the amounts of feed used in computing the cost of feed fed to the horses on the farms in this study are shown in Table 3. The feed prices used were those a farmer would have received or would have had to pay for feed at the farm. The price of feed in 1937 was considerably higher than in either 1938 or 1939, which is the reason for the high annual feed cost in 1937.

The relation of hours of horse work in the year to horse costs per year

Table 2. Average age of horses and percentage distribution in various age groups on some Michigan farms, 1937-39.

Item	1937	1938	1939	Average 1937-39
Number of farms	21	15	15	—
Number of horses, total	72	43	48	—
Average age of horses, years	11.4	13.3	12.9	12.3
Age groups:	Per cent in each age group			
Less than 7	21	19	21	20
7-12	26	27	22	25
13-18	34	23	43	33
19 and more	19	31	14	22

Table 3. Amounts of feed fed to horses and average feed prices on some Michigan farms, 1937-39.

Item	Unit	1937	1938	1939	Average 1937-39
Amount of feed fed per horse per year:					
Corn.....	bu.....	10	15	12	12
Oats.....	bu.....	37	28	33	34
Other grain.....	lb.....	20	05	92	65
Roughage.....	ton.....	4 3	3.4	3.7	3 9
Annual feed cost per horse....	..	\$62	\$44	\$44	\$52
Average feed prices:					
All grain.....	cwt.....	\$ 1 26	\$ 0.96	\$ 0.78	\$ 1.04
Roughage.....	ton.....	7 90	6 49	6.79	7.28
Pasture per horse.....	year.....	4.97	2.07	3.22	3.97

and per hour on the farms in this study is shown in Table 4. There are several interesting things to be noted in this table, one of which is the big variation in the number of hours horses were used on various farms. This ranged from an average of 495 hours for the one-third using horses the least to 1,122 for the group where horses were used the most. Annual costs tended to be higher where the horses were used the most, but the net cost per hour was much less; that is 8.3 cents an hour in comparison with 18.5 cents an hour for the least used group.

Figure 2 shows graphically the influence of hours of work per horse per year on hourly costs. It may be readily seen that the more hours horses are worked, the lower the net cost per hour. This chart also shows a little upward swing on the left end of the curve, indicating that the rate of increase in cost becomes greater when the number of hours the horses are worked is less than 600 or 700 hours per year.

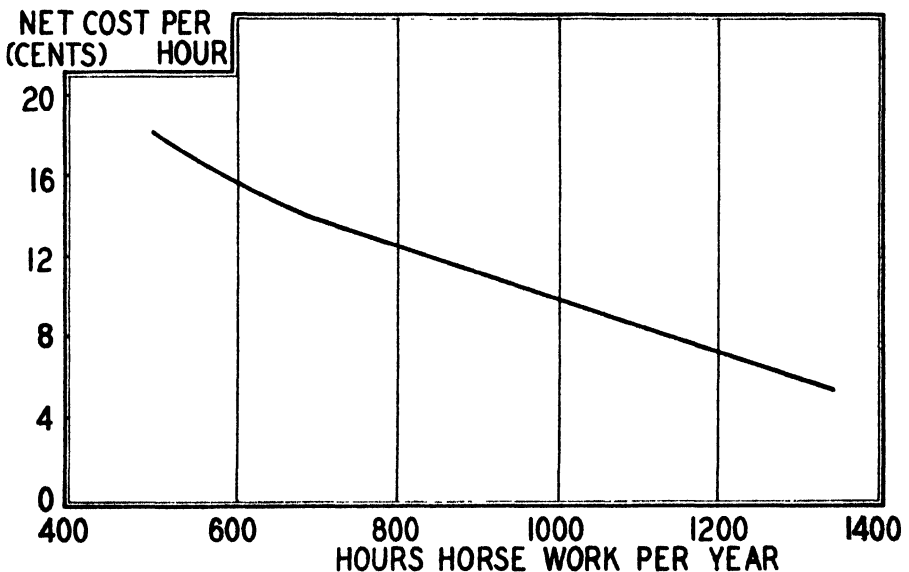
**Fig. 2. Influence of hours horse work per year on hourly costs of keeping horses in Michigan, 1939.**

Table 4. The relation of hours of horse work to horse costs on some Michigan farms, 1937-39.

Item	Hours horse work per year		
	Less than 600	600-799	800 and more
Number of farms	15	18	18
Total acres per farm	172	155	165
Crop acres per farm	108	97	104
Number of horses per farm	3 0	3.7	2.7
Average hours of horse work	495	687	1122
Annual costs per horse:			
Feed	\$ 48	\$ 49	\$ 60
Man labor	21	25	22
Depreciation	17	16	8
Other	19	25	22
Total	\$105	\$115	\$112
Net cost	92	100	93
Net cost per hour of horse work (cents)	18 5	14 5	8 3

Figure 3 shows the monthly distribution of the horse work on the farms in this study. May was the month when the horses were used the most. The hours of use in succeeding months decreased at a steady rate from then to the following January when they started increasing again.

Some significant comparisons of horse costs on farms where tractors were used and on farms where they were not used are shown in Table 5. As might be expected, the farms on which tractors were used were nearly 30 per cent larger than those without tractors. The tractor farms had larger businesses as shown by more productive man work units (P.M.W.U.) than those with-

Table 5. Comparison of labor and power costs per farm and per productive man work unit (P.M.W.U.) on farms having tractors to farms not having tractors in Michigan, 1937-39.*

Item	Farms with tractors	Farms without tractors
Number of farms	24	24
Number of men	1.9	1.6
Acres per farm	181	140
Crop acres per farm	116	81
P.M.W.U. per farm	480	357
P.M.W.U. per man	256	218
Horses per farm	2.7	3.6
Horses age	14.3	11.4
Hours worked per horse	705	789
Labor and power costs per farm:		
Man labor (own, family, hired)	\$ 981	\$ 874
Horse work**	269	296
Tractor use**	186	—
Total	\$1,436	\$1,170
Cost per crop acre	\$12.38	\$14.44
Cost per P.M.W.U.	2.99	3.28

*Only horse records were used in this table for which corresponding farm accounts were available.

**Man labor has not been included in this item, but in "man labor" above.

HOURS WORK EACH MONTH

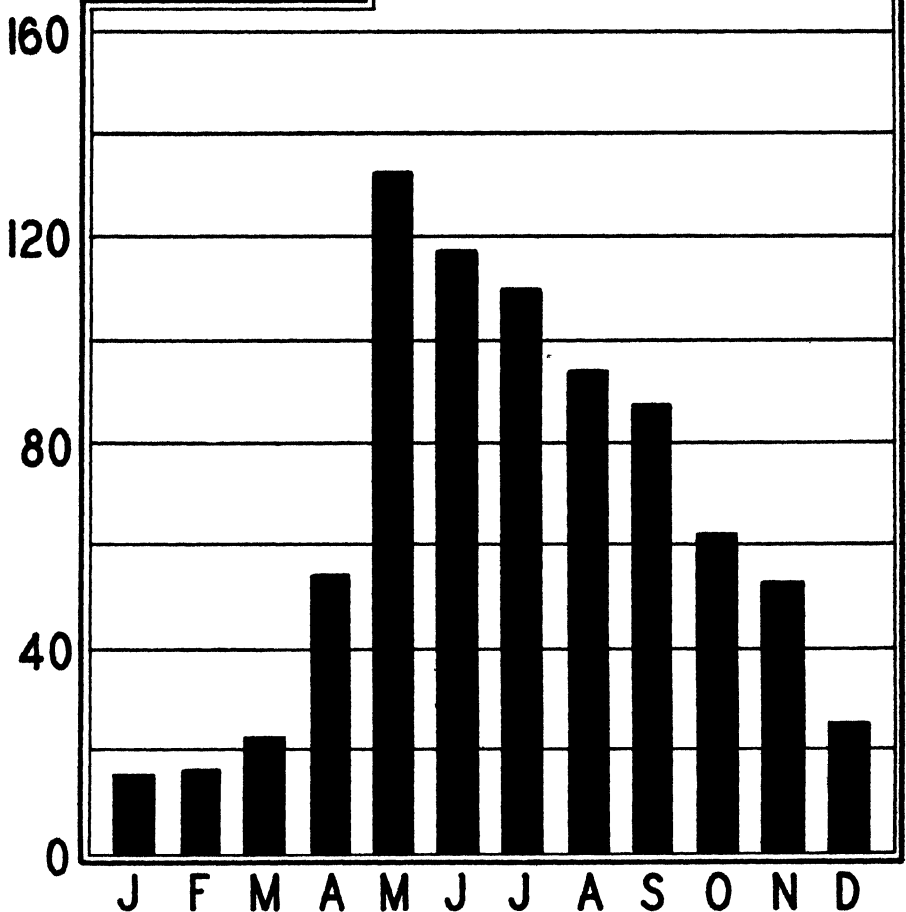


Fig. 3. Monthly distribution of horse work on some Michigan farms, 1937-39.

out tractors. These tractor farms also had more P.M.W.U. per man than the other group, indicating about 17 per cent greater efficiency in the use of man labor. The tractor farms had fewer horses and the horses were slightly older than those on the non-tractor farms. The horses were not worked as much on the larger tractor farms as they were on the non-tractor farms. Total labor and power cost per farm was considerably higher on the tractor farms than on the non-tractor farms, due primarily to their larger size. The labor and power costs per crop acre and per P.M.W.U., however, were appreciably lower on the tractor farms, indicating about 10 per cent more efficient use of labor and power on these larger, more mechanized farms.

In conclusion, one may say that a major lesson to be gained from this

study is that idle horses are expensive horses and one had better keep only those he needs. A farmer maintaining a tractor as well as horses should study his total power needs in some detail and be certain that he does not have more power available than he can use efficiently.

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OVEREATING (*Enterotoxemia*) IN FEEDLOT LAMBS*

FRANK THORP, JR.
SECTION OF ANIMAL PATHOLOGY

The most serious disease affecting lambs on feed is overeating. Data collected by the Colorado Agricultural Experiment Station (1939-40) show that this disease was encountered in about half the lambs submitted for autopsy. Reports from other lamb feeding areas indicate that considerable losses are experienced due to this condition.

The primary cause of the condition seems to be the eating of too much concentrated feed such as corn, cane, barley and peas.

The "lambling down" of corn, cane, and peas is for the most part an unsuccessful method of fattening lambs. The lambs appear to thrive well for a period of two weeks to a month at which time the disease begins to manifest itself. At about this time it is usually found that the leaves from the grain plants and grass from the fence rows have been consumed, leaving mostly grain as the diet. If a high wind should blow down the stalks making more grain available, large losses in lambs are usually encountered the next morning.

Losses from overeating may occur early in the feeding period. This may be true if the lambs are given too much grain at the beginning. Early losses have been observed during outbreaks of coccidiosis and sore mouth. In either disease all the animals are not affected to the same degree and, therefore, the affected ones eat but little while the others consume more than their share.

Overeating is truly an enterotoxemia since a thermolabile (rendered harmless by heating) toxin has been found in the small intestines of a large proportion of lambs dying of this condition.

Investigators at the Colorado Agricultural Experiment Station have shown that the contents of the small intestines from lambs dead of overeating are usually toxic for rabbits, guinea pigs, mice, rats and lambs when given subcutaneously or intravenously. The toxic intestinal contents are always neutralized by *Clostridium perfringens* antitoxin type D and usually by type B but never by types A and C. Experimentally the disease has not been produced by the oral feeding of the toxic material. However, the disease is probably due to the absorption of the toxin from the small intestines.

It is not unusual for lambs to be found dead in the morning despite the fact that the animals were apparently healthy the night before. Scouring among some of the larger lambs manifested by the matting of wool with fecal material around and below the anus should be a warning sign. The affected animals are invariably the largest, fattest, most vigorous and greediest lambs in the lots. A few of the animals may throw back their heads, stagger for a

*This paper is based on the result of researches by the author while connected with the Colorado Agricultural Experiment Station and is published with the permission of the Director of that Station.

little while, then fall and die in convulsions. Others often live for a few hours, either standing with heads drawn back or heads lowered, moving in a circle, pushing against the fence, or falling to the ground and lying there swinging their legs back and forth. Recovery is rare in this disease.

Gross lesions may not be observed in some of the acute cases. Whole grain is usually found somewhere along the digestive tract. Inflammation of the abomasum and small intestines is a common finding. The Peyer's patches are usually congested. Blotchy hemorrhages may be found under the peritoneum of the abdominal muscles, on the diaphragm, under the serosa of the intestines and abomasum. The pericardial sac usually contains straw-colored fluid which often shows some coagulum. Petechial hemorrhages are invariably present on the thymus. Petechial and ecchymotic hemorrhages may be present under the epi- and endocardium. In acute cases, at first sugar is usually present in the urine. If the animals live for a day or more, sugar usually is not found in the urine.

A history of fat lambs dying on full feed is indicative of overeating provided autopsy fails to reveal pneumonia and bacteriological findings are negative. The finding of sugar in the urine of acute cases is regarded as diagnostic. Among uninformed persons, overeating is sometimes mistaken for so-called "hemorrhagic septicemia". Likewise the presence of the fringed tapeworm (*Thysanosoma actinioides*) in the bile ducts and intestines is often erroneously given as the cause of the disease. Data obtained by the Colorado Agricultural Experiment Station do not substantiate this claim.

If sudden deaths occur when lambs are on full feed or if some go off feed this should indicate a reduction in the amount of grain fed. Death losses can be stopped overnight by withholding grain. The most satisfactory method of control is to decrease the grain to a point where no further trouble occurs and then increase it gradually. The animals should be lotted according to size and packed at the feed trough so that when a lamb leaves its place no other room is available. The grain should be evenly distributed in the troughs in order that each lamb may receive only its share. Such feeds as ensilage and beet pulp should be figured to take the place of some of the grain ration. Ensilage often contains from a fourth to a third of its weight in grain.

Improper management figures greatly in the complex disease overeating.

BULLETIN REVIEWS

Circ. Bul. 175—Sugar Beets in Michigan—Rather, H. C. *et al.*—This publication presents information on the sugar beet industry of Michigan, on culture of the crop, diseases and their control, production costs and various methods of utilizing crop residues. The material was contributed by seven departments of the Station. (53 pp., 6 tables, 29 figs.)

Spec. Bul. 304—Some Important Michigan Weeds—Darlington, H. T., Bessey, E. A. and Megee, C. R.—This bulletin presents a key to the identification and description of 94 of the more important weeds found in Michigan. Information is given on habitat and distribution and suggestions for control. (216 pp., 94 figs.)

Spec. Bul. 305—Sugar Beet Costs and Returns—Wright, K. T.—Sugar beet production costs on the farms in this study, producing about 10 tons of beets per acre, averaged about \$39 an acre for the period 1933-36. Marketing costs amounted to approximately \$9 an acre, making a total cost of \$48. Income totaled about \$70 an acre, leaving a net return of approximately \$22 an acre.

Approximately 85 hours of man labor was spent per acre, with about 70 hours being hand work, and 15 hours for the other operations. There was also an average of 26 hours of horse labor and $2\frac{1}{2}$ hours tractor use per acre, or a horse equivalent of approximately 40 hours.

The charge for hand labor made up one-third of the total cost of producing and marketing beets. The charge for the grower's own labor, use of power and machinery, made up about 18 per cent of the total, land use 16 per cent, other production costs 15 per cent, and marketing costs 18 per cent.

Total production cost per ton on the farms covered by this study varied from approximately \$3 to \$10, but a range of 80 cents a ton on each side of the average production cost of about \$4 a ton included one-half the growers, while a range of \$1.20 a ton on each side of the average included two-thirds of the growers. That is, the production cost of one-half the growers was between \$3.20 and \$4.80 a ton, and two-thirds between \$2.80 and \$5.20 a ton. The delivered cost was about \$1 a ton higher.

Growers having yields of around $6\frac{1}{2}$ tons per acre had a production cost of \$5.74 a ton, compared with \$3.21 for those averaging approximately 13 tons per acre. Net return per acre was more than 10 times as high for the high-yield as for the low-yield men.

Such factors as soil type, drainage, amount of manure and fertilizer applied, time of plowing and planting, and row width, all affected yield per acre and cost per ton. Other factors, such as acres of beets per farm, the grower's efficiency with labor, power and machinery, and the hand labor method, had considerable effect on the cost per acre and consequently per ton of beets. Distance to the plant affected the marketing cost, and consequently the net return, the same as did differences in production cost per acre or yield of beets. (45 pp., 33 tables, 12 figs.)

JOURNAL ARTICLE ABSTRACTS

Some Soil Factors Affecting Boron Availability—Cook, R. L. and Millar, C. E.—*Soil Sci. Soc. Amer. Proc.* 4: 297-301. 1939. [Journal Article No. 414 (n. s.) from the Michigan Agricultural Experiment Station.]—The research outlined in this paper was an attempt to correlate the occurrence of heart rot of sugar beets with soil conditions. Partial analyses of 130 field soil samples were compared with the incidence of heart rot on the soils sampled. These data show that heart rot occurred more often on alkaline than on acid soils, and a positive correlation was found, within each group separately, between heart rot occurrence and the active calcium content of the soils. (Active calcium content was determined by leaching 10-gram samples of the soils with acidified ammonium acetate). No correlation was found between heart rot occurrence and the available B_2O_3 content of the surface soil. Field observations indicated, however, that excessive leaching was conducive to heart rot occurrence. By the use of pot cultures it was discovered that soybeans were easily injured by an excess of borax in the soil and that the toxicity symptoms, which occurred as yellowish-brown spots around the edges of the leaflets, can be recognized easily. Soybeans, accordingly, were used to measure the availability of boron applied to the soil in borax. It was found, thereby, that calcium and magnesium carbonates very effectively fixed boron in some chemical form unavailable to soybeans, while sodium carbonate had no effect on its availability. Calcium and magnesium sulphates caused boron to be partially fixed in a form not available to soybeans in the Hillsdale soil, but they had no effect in the Warsaw soil. Sodium sulphate had no effect in either soil. These results indicate that the boron of borax is fixed in the soil as insoluble borates of calcium and magnesium, which form chiefly in alkaline soils.

A Comparative Study of the Insect Food of Trout—Morofsky, W. F.—*Jour. Econ. Ent.* 33 (3): 544-547. 1940. [Journal Article No. 417 (n. s.) from the Michigan Agricultural Experiment Station.]—A study of the insect content of the stomachs of 1,548 trout taken from northern and southern Michigan trout streams discloses that 95 per cent of the insects eaten belong to a few groups. It is apparent that in the material examined insects far outnumbered all other animals. Consideration of the insects consumed by the three species of trout in Michigan streams indicates that certain kinds are eaten in very large number by brook and brown trout, but that rainbows are more or less general feeders; also, the insects eaten are similar in northern and southern Michigan streams.

Cerebrospinal Fluid Pressure and Vitamin A Deficiency—Moore, L. A. and Sykes, J. F.—*Am. Jour. Physiology* 130 (4): 684-689. 1940. [Journal Article No. 421 (n. s.) from the Michigan Agricultural Experiment Station.]—The authors have shown that a deficiency of vitamin A in the ration of the young bovine produces an increased cerebrospinal

fluid pressure. The increase in pressure is accompanied by papilledema, nyctalopia, syncope, and incoördination. The above disturbances slowly disappeared when the animals were returned to a normal ration or when crystalline carotene was added to the deficient ration.

Borax as a Control for Heart Rot of Sugar Beets—Cook, R. L.—Better Crops with Plant Food. 24 (5):12. 1940. [Journal Article No. 422 (n. s.) from the Michigan Agricultural Experiment Station.]—Sugar beets, grown in Thomas sandy loam pot cultures, were supplied with a complete nutrient solution as a control treatment. Copper, manganese, magnesium and boron were separately omitted from and doubled in quantity in the control treatment solution to ascertain the effect of each of these elements on the development of the plants. Borax, applied at the rate of 10 pounds per acre, prevented heart rot, practically doubled yields and significantly increased the sucrose content of sugar beets. Copper, manganese and magnesium neither prevent heart rot nor affect the yield and sucrose content of sugar beets.

During 1937, 1938 and 1939 experiments were conducted in 10 fields located on six soil types. Borax, included in 2-12-6 fertilizer, was applied broadcast and in the row at rates ranging from 10 to 80 pounds per acre. In one experiment borax was applied as a side-dressing. The effect of heart rot on sucrose and purity percentages was determined by collecting samples from fields not included in the experiments.

When applied broadcast at rates as high as 80 pounds per acre borax did not injure stands nor reduce yields. When applied in contact with the seed at the rate of 10 pounds per acre, this material caused injury on one field in 1939 but did not reduce the stand on seven other fields in 1938 and 1939; as much as 40 pounds of borax applied with the seed did not reduce the stand on some soils. Applied in a band at the side of the seed, borax was much less harmful to stand than when applied in contact with the seed.

Borax applied broadcast or with the seed did not significantly increase sugar beet yields. Significance would probably have resulted in some cases had it been possible to better control experimental errors. Borax applied as a side-dressing on an area where heart rot was very severe significantly increased total sugar beet yields and more than doubled the yield of normal beets.

Borax applied in the row at the rate of 10 pounds per acre almost completely prevented heart rot occurrence. Broadcast applications at the same rate were somewhat less effective and on one field the 20-pound application produced significantly better results than did the 10-pound application.

Sugar beets having heart rot contained less sucrose than did normal beets and on one field the sugar beets having heart rot had a lower percentage purity than did normal beets.

Relation of Boron to Heart Rot in the Sugar Beet—Cox, T. R.—Jour. Amer. Soc. Agron. 32:354-370. 1940. [Journal Article No. 424 (n. s.) from the Michigan Agricultural Experiment Station.]—Sugar beet seedlings were grown in quartz sand cultures, with and without borax. Seedlings grown in jars without borax developed characteristic deficiency symptoms as follows: blackening of tips of heart leaves, followed by death of growing portion of crown; shortened, twisted

petioles associated with crinkled condition of leaves; pimped condition of petioles in early stages, followed by breakdown in form of cross and linear checking; abnormally dark green and thickened leaves, accompanied by more rapid wilting; yellowing and eventual death of outer leaves; stunted second growth leaves following death of first leaves; breakdown of beet root heart; darkened areas under the surface of the root and development of surface cankers; restricted fibrous root system. Symptoms appeared about two months after seedlings were transplanted and yields were increased as much as 80 per cent by borax applications. Seedlings showing advanced stages of heart rot definitely recovered upon the application of 4.9 mg. of borax per 5000 gm. sand. Halves of field-grown mother beets planted in quartz sand cultures without borax produced stunted leaves with marked symptoms of boron starvation, whereas the corresponding halves which received like treatment but with borax added at the rate of 2 mg. per 5000 gm. sand, produced a more abundant leaf growth free of deficiency symptoms. Soil tests for available boron showed that a crop of sugar beets produced in pot cultures removes an appreciable quantity of boron from the soil. By determining the quantity of B_2O_3 in leachates from pot cultures it was found that it was relatively easy to remove added borax from soils by leaching with distilled water even a year after the borax was applied.

Rumen Digestion in the Bovine, with Some Observations on the Digestibility of Alfalfa Hay—Hale, E. B., Duncan, C. W., and Huffman, C. F.—*Jour. Dairy Sci.* 23 (10): 953-967. 1940. [Journal Article No. 430 (n. s.) from the Michigan Agricultural Experiment Station.]—Methods of studying rumen digestion in the bovine were investigated and the use of lignin ratios is proposed as a method of quantitatively determining digestion in the rumen. Iron ratios were not reliable for this purpose. The lignin index is relatively accurate and it was found by its use that 90 per cent of the digestible dry matter, all of the digestible N. F. E., other carbohydrates and new N. F. E., 85 per cent of the digestible cellulose, almost two-thirds of the digestible crude fiber, and 59 per cent of the digestible protein of alfalfa hay were removed from the ingesta by rumen digestion. Lignin was not appreciably digested in the rumen but was digested to some extent in the remainder of the digestive tract. Ether-extractive substances accumulated after the ingesta passed from the rumen. True fat was not digested to any extent in the rumen and at the 30-lb. level of feeding there was an increase in true fat. This suggests the synthesis of fat by rumen micro-organisms.

Rumen pH averaged 6.82 and the maximum acidity was reached six hours after feeding. Rumen temperature approximated 39° C. The character and amount of rumen fill were not affected by the amount of hay consumed. The rumen was capable of digesting highly variable quantities of roughage with equal efficiency. All nutrients were less digestible (total digestion) at a sub-maintenance level of nutrition, but otherwise the plane of nutrition did not have any marked effect on the digestibility of the hay.

The separation of the carbohydrate fraction into lignin, cellulose and other carbohydrates is a better index to the biological value of alfalfa hay than the present division into crude fiber and N. F. E. An

enzymatic determination of crude fiber gave a much sharper distinction between the two carbohydrate fractions than the common method. A true fat determination was of greater biological significance than the ether extract determination.

Isolation of Carotene from Green Plant Tissue—Petering, H. G., Morgal, P. W. and Miller, E. J.—Ind. and Eng. Chem. 32: 1407-1412. 1940. [Journal Article No. 431 (n. s.) from the Michigan Agricultural Experiment Station.]—A new method, much less difficult than methods heretofore available, for extracting carotene from plant tissue is briefly described as follows: Dehydrated alfalfa leaf meal is extracted with acetone. The extract is refluxed with solid barium hydroxide octahydrate. This causes chlorophyll and saponifiable lipoids to be removed as a green sludge. The solution is concentrated until a waxy residue containing the carotene separates, leaving flavones and other water-soluble constituents in solution. The waxy residue is extracted with cold acetone; most of the carotene and xanthophyll and some of the lipoidal matter go into solution. The extract is concentrated to an oil, taken up into petroleum solvent, and purified of contaminating xanthophyll and lipoidal matter by available method. The simplicity of the method is due to the procedure devised for removing chlorophyll and saponifiable lipoids. The efficiency of the barium hydroxide octahydrate treatment is dependent on the particle size of the solid and on the ratio of acetone to water in the solution of plant pigments. Proteins, carbohydrates, cellulose, and other plant materials not extractable are not destroyed in this procedure.

Twelve New North American Species of *Oscinella* (Diptera, Chlopidae)—Sabrosky, C. W.—Canadian Entomologist. 72 (11): 214-230, 1 plate. 1940. [Journal Article No. 444 (n. s.) from the Michigan Agricultural Experiment Station.]—The genus *Oscinella* includes a number of species of small flies whose larvae attack various grains and grasses. One such species sometimes causes losses of 10 per cent or more to the wheat crop in some parts of Europe. The present contribution to the classification of the American species recognizes 12 kinds new to science.

Two Hundred Tell What They Prefer in Pickle Sweetness—Switzer, R. G. and Fabian, F. W.—Food Industries. 12 (11): 38-40. 1940. [Journal Article No. 445 (n. s.) from the Michigan Agricultural Experiment Station.]—To determine the relative merits of two commonly used sweetening agents for pickles, four series of jars were prepared. In the first two the sugar was kept virtually constant at 37° Brix to 20.3° Baume and the acidity kept at two levels, 2.0 and 2.28 per cent acid, calculated as acetic. In the second experiments the sugar was kept constant at approximately 18.2° Baume and the acidity varied as in the first series. Three combinations of sugar were used in all experiments as follows: 100 per cent sucrose, a combination of 75 per cent sucrose and 25 per cent dextrose, and a combination of 50 per cent sucrose and 50 per cent dextrose. Several hundred jars in each series were available for testing.

Jars of all the various combinations were then sent to 40 different pickle companies and food laboratories to obtain a representative cross section of opinion from all parts of the country. Approximately 200 people compared the flavor and general palatability of the different

series of pickles. The samples were marked in code so as to preclude the possibility of identification of the various combinations. The tasters were asked to record their preference in each series as first, second and third choice. The results of the tasters' preference for the various combinations may be summarized as follows:

The ideal combination of sucrose and dextrose in a 20° Baume, sirup at 20 grains acidity is 75 per cent sucrose and 25 per cent dextrose.

Increasing the acidity 2.8 grains in a 20° Baume sirup decreased the number of first choices in the sucrose-dextrose combination as compared with sucrose alone.

Reducing the sugar concentration from 20° to 18° Baume at 20 grains acidity decreased the number of first choices, but not so much as increasing the acidity 2.8 grains at 18° Baume.

Increasing the acidity 2.8 grains in both the 18° and 20° Baume sirups reduced the number of first choices in both the sucrose-dextrose combinations as compared to sucrose alone.

The tasters were more sensitive to slight increases in acidity than they were to slight reductions in sweetness.

There is a very definite ratio between the grains acid and the degrees Baume in pickles. Within practical limits, for every grain increase or decrease of acetic acid there should be a corresponding increase or decrease of one degree Baume.

Control of Cedar Rust with Sodium Dinitrocresylate—Strong, F. C. and Cation, D.—*Phytopathology* 30 (11):983. 1940. [Journal Article No. 447 (n. s.) from the Michigan Agricultural Experiment Station.]—A 1-per cent solution of Elgetol (sodium dinitrocresylate) was sprayed on red cedar trees bearing galls of the cedar-apple and cedar-hawthorn rust fungi. One application was made when the galls were showing activity in May 1940. Telial column (horn) extension and spore germination were completely inhibited. No injury to the foliage of red cedar was observed. Slight injury to foliage of some quince rust infected dwarf juniper branches occurred.

The success of these preliminary tests gives promise of the development of a simplified spray control of these two rusts so troublesome on ornamental plantings. One spray application on the coniferous host at the proper time appears to prevent the infection of the pomaceous host, eliminating the necessity of spraying the latter.

Identification of *Salmonella pullorum* Colonies with Immune Serum by means of a Microscopic Plate Test—Stafseth, H. J. and Corbett, A. C.—*Am. Jour. Vet. Res.* 1 (1):76-77. 1940. [Journal Article No. 456 (n. s.) from the Michigan Agricultural Experiment Station.]—The method of isolating and identifying the *pullorum* disease organism usually employed is as follows: Cultures from tissues thought to harbor the germ are made on plain agar or brilliant green agar plates, which are incubated at 37° C. overnight. If colonies resembling those characteristic of *S. pullorum* are found, transfers are made to agar slants which are incubated overnight. When sufficient growth has been obtained, several different fermentation media are inoculated and incubated as before, overnight or until typical fermentation reactions are obtained. Usually a minimum of 72 hours is required.

A method of diagnosis is explained which requires that a sufficient

amount of growth be obtained for a turbid suspension of the organisms in a large drop of a very potent agglutinating serum. When this mixture is made, clumping (agglutination) will take place instantly if the organism is *S. pullorum* or *Salmonella gallinarium*, the cause of fowl typhoid. These two organisms are so closely related that the diseases caused by them may well be considered as one problem. The time required for this procedure is 15 to 48 hours.

Vibronic Abortion in Michigan Sheep—Ryff, J. F.—Jour. Am. Vet. Med. Assoc. 97 (764): 452-453. 1940. [Journal Article No. 466 (n. s.) from the Michigan Agricultural Experiment Station.]—Vibronic abortion in sheep, previously reported in New York, Illinois and Montana, was identified in three flocks of Michigan sheep for the first time. In one flock of 79 sheep, 37 lambs from 25 ewes were lost through this cause, although no fatalities were encountered in the ewes. *Vibrio fetus* was recovered from four lambs examined. Thirty-seven of the 79 sheep had a positive agglutination reaction in 1:25 dilution; 10 were positive in 1:100 dilution. Six of the latter samples were from sheep that had aborted. Nine normal sheep from an uninfected flock did not react in 1:25 dilution. Because no new sheep had been introduced and the cattle on this farm showed no significant reaction to the agglutination test, a neighboring flock of sheep troubled by abortion may have served as the source of infection.

Simple Turkey Curing and Smoking Method Developed—Schaible, P. J., Davidson, J. A. and Sykes, J. F.—The National Provisioner. 103 (11): 17-18. 1940. [Journal Article No. 469 (n. s.) from the Michigan Agricultural Experiment Station.]—Using the facilities of a commercial packing plant, a practical method of curing and smoking turkey was developed.

Equipment and materials in common use for pork curing and smoking were found adaptable to processing turkeys but the procedure was very different. Smoked turkey was preserved indefinitely by hard freezing.

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**EDITED BY
V. R. GARDNER AND A. A. APPLIGATE**

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BRUCELLOSIS (BANG'S DISEASE AND UNDULANT FEVER) THE STORY OF RESEARCH DEALING WITH THEIR INTERRELATIONSHIPS

Just where and when Bang's disease of cattle and other animals first appeared or first caused serious losses no one knows, though it is known that it is of Old World origin and the presumption is that it was widely distributed many centuries ago. There is evidence to indicate that the goat or *melitensis* type of the disease was first introduced into the western hemisphere when Cortez in 1521 brought to Mexico goats from Spain, and the early spread of this type was coincident with Spanish penetration in the pre-colonial and colonial days. Similarly the bovine form of the disease was probably brought to America by the French, and perhaps other northern European settlers. Anyway, well over a century ago it seems to have been widely prevalent in Louisiana and only slightly later in many of the other centers of population developing from early European colonization.

How serious were the losses caused by this disease no one knows. Because of the insidious nature of the disease, even today many losses that in reality are due to it are unrecognized as such and are attributed to other causes. It is little wonder, therefore, that, though prevalent and levying directly and indirectly a steadily mounting toll, it failed to attract the attention given perhaps more obvious and spectacular but less serious disorders—for instance, lumpy jaw or the foot and mouth disease—and was, more or less ignored until distribution became almost universal. Thus the situation essentially remained until 1910 when Dr. Ward MacNeill of the Illinois Agricultural Experiment Station isolated what was assumed to be the causal organism from aborted fetuses of infected cattle. Publication of the Illinois findings aroused the interest of scientific workers in the animal disease field and stepped up the tempo of researches dealing in any way with abortion.

Diagnostic Studies—Previous to the Illinois studies establishing a bacterium as the cause of the disease in the United States, no specific methods were available for a definite diagnosis of its presence in living animals, though studies of serological methods of diagnosis were begun in England in 1909. The first of such serological studies in the United States was conducted at the Wisconsin Agricultural Experiment Station in 1912 by Drs. F. M. Surface and W. P. Larsen, to be followed in 1915 by similar studies at the Michigan Station. As a result of the Wisconsin, Michigan and other studies during the next few years, the diagnostic methods were improved and more or less standardized so that by 1920 they had come into at least limited use by veterinarians throughout the United States in detecting infected animals. In 1926 the so-called "rapid" serological agglutination test was perfected at the Michigan Station, reducing the time required for such a test from 48 hours to 3 minutes. It was this improvement in technique that made practicable the widespread testing of cattle by veterinarians and laid the basis for some degree of practicable control through the segregation of infected from non-infected stock—a method, incidentally, that still continues

to be the principal means of preventing greater spread of the disease and gradually reducing its incidence in cattle.

At this point mention should also be made of the fact that it was in 1920 at the Michigan Station that the organism of the bovine form of contagious abortion was first isolated by culture methods from milk and methods of growing the organism in cultural media were developed, methods that came into general use about 4 years later. This, incidentally paved the way for control of spread through milk by pasteurization.

The Bovine, Goat and Swine Types—Mention has been made of the introduction of two forms or types of the disease, the goat type from the Mediterranean region and the bovine or cow type from central and northern Europe. In 1929 Dr. I. F. Huddleson of the Michigan Station, who, together with Dr. Ward Giltner, had been in charge of the Station's contagious abortion studies almost from their beginning in 1915, was sent by the U. S. Public Health Service to Tunis, North Africa, to study the disease in goats. Upon his return to the United States he began an intensive study of the two forms of the disease known to be present here and also of what was suspected to be a third form affecting swine. Through various laboratory and cross-inoculation studies (1930-35), the specific characteristics of this latter type were determined, and it was named and described. Practicable methods of differentiating between all three types were worked out at the Michigan Station and it was learned that while the cow or bovine type **does not** infect hogs, the swine type infects cows. The goat type infects both swine and cows and both of the latter types infect goats. By 1935 the similarities, differences and interrelationships of the several forms of the disease were pretty well established.

Brucellosis in Animals and Undulant Fever in Man—The peoples of the Mediterranean region have long been troubled with a disease that has come to be known as Malta fever, because of its high incidence at one time on the island of Malta. Like the so-called common cold or the influenza diseases of today comparatively little has been known of its causes, its methods of spread or its control, even though it has at times assumed almost epidemic proportions and has at all times been a serious health problem. A more or less similar, though less widespread disorder in central and northern Europe and in the United States has been known as undulant fever, so named because of one of its more or less characteristic symptoms. As in the case of Malta fever, the cause, control, and even the definite diagnosis of undulant fever have puzzled the physician. Furthermore, the disease was not generally considered to be distinct from Malta fever.

As early as 1916 it was suspected that the organism causing Bang's disease might infect human beings, so Professor Cooledge and Dr. Huddleson at the Michigan Station conducted some experiments to determine if it is possible to infect human beings with cultures causing Bang's disease. No clear-cut, positive results were obtained from those early experiments.

In 1918 Dr. Alice Evans, working in one of the laboratories of the United States Department of Agriculture, found and reported on an apparently close resemblance between cultures of the organism causing Bang's disease in cattle and organisms cultured from certain undulant or Malta fever patients, and raised a question as to a possible relationship between the two. It was not until 1924, however, that the first case of undulant fever in man in the United States was definitely established as not being of the Malta fever type. This was in the hospital at Johns Hopkins University. The following year the

studies at the Michigan Station, first begun in 1916 and then temporarily dropped, were resumed and an intensive series of studies was begun to determine the possible relationship between undulant fever in humans and the forms of brucellosis then recognized in domestic animals. A typical undulant fever case developing in our Bacteriological Laboratory that year (1925) tended to confirm the suspicion that had been gradually forming that such a relationship existed. This suspicion was regarded as an established fact in 1927 when a study of the earlier incidence of the disease in a large group of veterinarians revealed that 52 per cent had, at one time or another, contracted the disease and recovered from it, a percentage far above that found in any other occupational group, where there would not be the opportunity to contract the disease from infected animals. The disease was then given the name brucellosis by the Michigan workers, after the generic name (*Brucella*) of the organism causing it. It has recently been established that of the 3 types of organisms infecting domestic animals, the swine type is the most virulent for animals and man and the cow type the least virulent. Thereafter a major project at the Michigan Station has been a study of the human aspects of the disease and an attempt to develop certain therapeutic and diagnostic agents.

Brucellergen and Brucellin—In the successful treatment of any disease the first essential is a definite, specific diagnosis. Though the agglutination serologic and other tests had been developed for the diagnosis of the presence of Bang's disease in cattle and goats, and could be employed for the detection of the presence of undulant fever organisms in human beings, more sensitive tests were desirable. As a result of studies begun in 1929 a diagnostic skin test agent, Brucellergen, was perfected in 1934. This is a positive diagnostic agent and has gradually come into widespread use in hospitals and by physicians throughout the country. The Bacteriological Laboratory at the Michigan Station, the only source of this therapeutic agent at the present time, now supplies hospitals and physicians with Brucellergen sufficient for about 5,000 tests per month.

In 1936 another product, Brucellin, was perfected in the laboratories of the Michigan Station. This is a curative agent for undulant fever and, like its companion product Brucellergen, is supplied to hospitals and physicians throughout the United States and in many foreign countries. Enough is being produced for the treatment of about 1,500 cases per year—resulting in about 80 per cent recoveries. The year 1936 is given as the time when Brucellin was perfected. That date, however, is arbitrary. A crude form of Brucellin, or perhaps more accurately an antecedent or precursor of the Brucellin of today, had been developed and was being used in the treatment of undulant fever in human beings as early as 1930. By 1936 a greatly improved, purified, and fairly well-standardized product had been developed. Since 1936 improvements have been made in both Brucellin and Brucellergen and a much greater degree of standardization obtained.

Costs and Support—and Returns—As indicated near the beginning of this short article, the study of Bang's disease in cattle, that later broadened out into a study of undulant fever in man, was begun in 1915 as a regular Experiment Station project. It cost an estimated \$5,000 per year for personnel, laboratory supplies and equipment. As the project developed, however, larger allotments had to be made. In 1940 it is estimated that for personnel, experimental animals, and laboratory assistance, supplies and equipment, approximately \$12,000 of Experiment Station funds and \$9,000 from special

grants went for the support of this project. Had it been necessary to limit the studies to what could be done with Agricultural Experiment Station funds, however, progress would have been much slower. Fortunately, much additional financial support was obtained from other sources. As a matter of fact a considerable number of public-spirited individuals and outside agencies have at one time or another contributed to the support of this investigation, though by far the largest contributions have been received from the Commonwealth Fund Inc. of New York City and the Rackham Foundation of Detroit. For a number of years the study has also been aided by a grant of \$3,500 annually from the Bureau of Animal Industry of the United States Department of Agriculture. This has been primarily to help finance a study of the possibility of immunizing cattle against Bang's disease by means of inoculation with avirulent cultures, and to help to defray the cost of maintaining a collection of standard cultures of the disease with which cultures sent in from all over the world can be compared and typed. Thus public and private funds together have made possible an effective study of an important animal disease and public health problem.

And the results? Obviously they cannot be given in terms of so many dollars returned in the way of dividends from so many dollars invested. The returns from some types of research can be thus evaluated, but not research of the kind described here. As a matter of fact there is no known yardstick by which the results can be accurately or adequately measured. It is safe to say, however, that the progress that has been made toward dealing with Brucellosis as a disease of certain domesticated animals and toward the diagnosis and treatment of undulant fever in human beings is such as to repay many times both public and private costs.

What next?—Is the problem, or are the problems, of Bang's disease and undulant fever all settled? Far from it. Much progress has been made, but much yet remains to be learned and to be done. For instance, what other animals may harbor the disease, or, if they do not harbor it as infected animals, may otherwise aid in its spread to uninfected animals and to human beings? What are the really effective chemical constituents of the present therapeutic agents that are used for the diagnosis and control of undulant fever in man? How about synthesizing them in the laboratory? Can agents or products be developed for immunizing both man and domesticated animals against this group of diseases? These and many other related questions are the subject of today's—and tomorrow's—studies.

V. R. GARDNER, DIRECTOR,

MICHIGAN AGRICULTURAL EXPERIMENT STATION.

PRICES AND COSTS FOR MICHIGAN FARMERS

ORION ULREY*
SECTION OF AGRICULTURAL ECONOMICS

The purpose of this study and report is to bring up to date the statistical data and the analysis of the relationship of prices of Michigan farm products and the farm cost items. Michigan Technical Bulletin 139, "Michigan Farm Prices and Costs," which was published in 1934 traced the price situation of Michigan's agriculture from 1910 to 1934. An article on "Farm Prices and Costs in Michigan," published in Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 20, No. 2, November 1937, covered the period through 1936.

Price Index of Michigan Farm Products

The prices of 20 Michigan farm products are collected and constructed into an index as follows:

1. **Source of Price Data**—The monthly prices from which the index is calculated are reported for the fifteenth of each month by about 700 Michigan farmers. The reports are sent to the state and then to the federal office of the U. S. Department of Agriculture, where state averages are prepared.

Table 1. Percentage of total value of the 20 farm products used in Michigan farm price index. (1910-14 prices, 1924-28 quantities sold.)*

Product	Per cent	Product	Per cent
Wheat.....	8 43	Cattle	7 81
Rye.....	82	Calves	3 30
Beans.....	7 35	Hogs	10 00
Potatoes.....	5 93	Sheep .....	.28
Clover seed.....	.51	Lambs.....	2 88
Apples.....	1 77	Wool	1.08
Cash crops.....	24 81	Meat animals and wool	25.35
Corn.....	40	Chickens.....	3.42
Oats.....	2 27	Eggs.....	8.80
Barley.....	25	Poultry and products	12.26
Alfalfa hay.....	3 18	Milk.....	17.50
Feed crops.....	6.10	Butterfat.....	13 98
		Dairy products.....	31.48
		Twenty farm products.....	100.00

*For alfalfa hay, the quantities sold during 1932-36, or 320,000 tons were used in weighting the index. An average of 868,000 bushels of clover seed was marketed annually during 1924-28. See Table 1, p. 6, Mich. Tech. Bul. 139 for quantities of other products sold annually.

*Considerable of the statistical data were assembled and organized by Richard Hartwig, student majoring in Agricultural Economics.

2. **Farm Commodities Included**—All farm products for which price data are available on a monthly basis for a series of years are included. Five groups of farm products are represented: cash crops, feed crops, meat animals and wool, poultry and products, and dairy products. The major groups of farm products are adequately represented, except for the fruits and vegetables—apples being the only one of these products for which continuous data are available.

3. **Base Period**—The pre-war years, 1910-14, are retained as the base period. Farm prices more than doubled during World War I, but have returned to the approximate levels of the base period. The use of this base period permits showing the effects of the inflation of 1916-20 and the deflations of 1920-22 and 1929-32 upon farm prices and costs. The 1910-14 period was not favorable to agriculture in the United States inasmuch as the per capita cash income of farm people was only about 45 per cent as high as for urban people.

Table 2. Index numbers of prices of Michigan farm products, 1910-41
(1910-14 = 100). (Weighted aggregative of 20 farm products.)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average*
1910-14	108	105	103	98	97	95	99	102	104	104	106	108	100
1924-28	161	160	155	155	153	152	154	156	154	157	162	166	154
1910	110	105	108	101	97	95	96	101	104	102	101	101	100
1911	99	94	91	85	82	81	91	97	97	98	103	106	90
1912	109	108	108	110	108	104	103	102	102	104	106	109	104
1913	109	108	98	94	96	96	98	102	105	110	111	115	102
1914	113	111	108	101	100	102	105	108	110	108	109	109	104
1915	115	114	109	106	104	102	102	101	103	109	113	119	105
1916	121	124	123	121	120	120	128	128	141	148	161	164	133
1917	170	182	189	204	215	209	195	191	192	203	202	210	191
1918	207	213	205	198	192	184	195	209	217	217	217	228	201
1919	225	223	209	221	221	212	226	240	228	225	229	236	217
1920	242	243	241	251	255	247	242	223	214	201	195	172	219
1921	164	141	142	129	118	117	128	149	147	144	145	147	135
1922	134	142	141	139	144	147	147	136	128	134	144	158	131
1923	154	150	150	145	140	135	138	144	151	148	150	149	143
1924	146	146	135	131	127	129	134	139	138	143	144	150	137
1925	157	155	154	149	148	152	154	160	154	150	175	178	153
1926	179	174	168	173	170	169	157	155	154	157	165	168	155
1927	163	160	154	153	151	158	159	157	155	160	162	165	155
1928	161	163	165	170	168	164	168	168	168	165	166	169	163
1929	169	171	171	161	161	157	160	176	171	179	176	170	165
1930	162	157	147	147	144	140	134	137	145	138	131	122	144
1931	116	109	108	109	101	96	94	96	93	88	87	83	94
1932	75	70	69	67	62	61	68	65	66	66	66	66	64
1933	62	58	58	61	70	70	90	91	91	85	86	80	73
1934	80	89	90	87	85	86	88	96	101	96	98	98	89
1935	105	111	108	111	106	101	100	104	106	108	110	113	104
1936	112	116	109	109	107	114	129	137	134	132	136	138	120
1937	141	144	144	143	138	135	135	129	127	124	122	121	132
1938	117	108	109	104	102	101	107	99	101	102	104	103	102
1939	100	99	98	95	95	92	96	95	107	106	109	107	97
1940	109	111	108	108	107	103	106	105	108	110	114	118	106
1941	115	112	112										

*The monthly prices are weighted by the percentage marketed monthly to determine the weighted average annual prices. The percentage marketed each month is shown in Table 68, p. 93, Mich. Tech. Bul. 139

4. Weighting and Calculation—Each of the 20 farm products included in the index was weighted on the basis of the average annual quantity sold during the five-year period, 1924-28, except for alfalfa hay for which 1932-36 quantities were used. Each of the groups of products is calculated separately, and then the five groups are combined on the basis of values to obtain the weighted aggregative index for the 20 products (Table 1).

Farm prices in Michigan reached a peak index of 255 in May 1920, or 155 per cent above the 1910-14 level (Table 2). Prices fell during 1920-22, improved some during 1922-29, declined again during 1929-32, touching a low of 61 per cent of pre-war in June 1932. Farm prices again rose to a high of 144 in February and March of 1937, declined for the next two years, and have been slowly improving during the last two years. They stood at 112 in March 1941, or only 12 per cent above the base period.

The General Price Level

The wholesale price index of all commodities, based on data collected by the U. S. Bureau of Labor Statistics, is used to show the changes in the average level of prices of all kinds of commodities and services. This index is very satisfactory because it contains raw materials, semi-processed products and finished goods.

The major trend in the price level during the past 140 years has been one of the most important factors responsible for the wide changes in relative income of the economic groups of our society (Fig. 1).

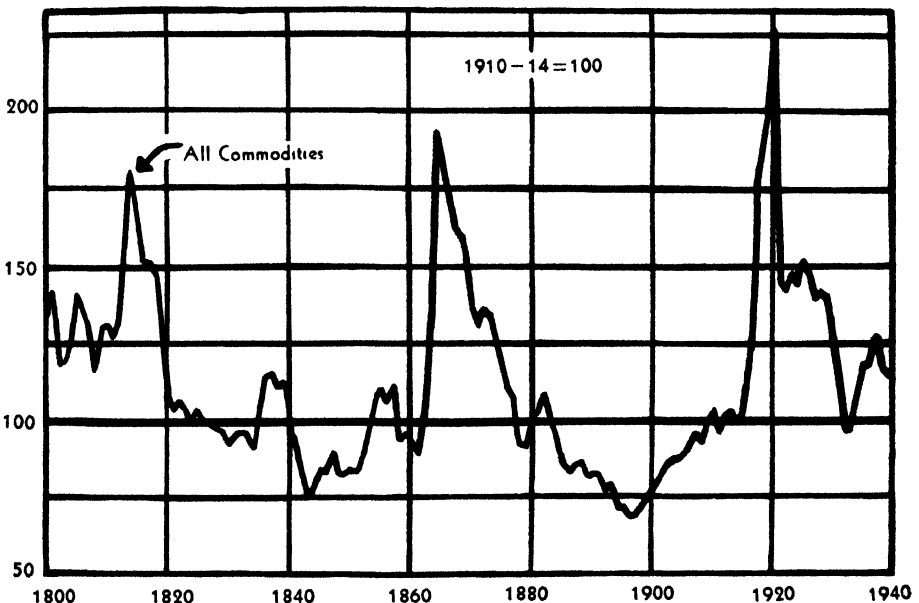


Fig. 1. Index numbers of wholesale prices of all commodities, 1800-1940.

The change in the price level since 1800 has been an important reason for the wide variations in the economic situation of farm people. Farmers have been relatively prosperous during periods of inflation or rising prices, and have been adversely affected by deflation or falling prices.

Table 3. Index numbers of farm food prices, wholesale food prices, retail food prices, cost of distributing food and industrial wages in the United States, 1929-40.*

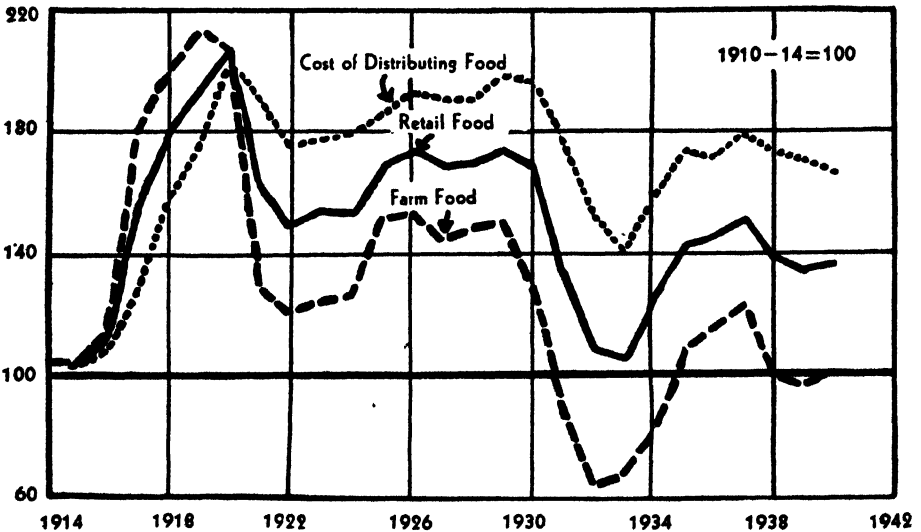
Year	Farm food prices**	Wholesale food prices***	Retail food prices**	Distribution costs**	Industrial wages****
1910-14	100	100	100	100	100
1924-28	145	151	167	188	232
1929	151	155	174	198	242
1930	130	141	169	196	232
1931	90	116	135	177	213
1932	65	95	109	153	183
1933	69	94	106	140	176
1934	83	109	122	157	187
1935	109	130	143	173	192
1936	117	125	146	171	200
1937	124	133	152	179	215
1938	100	114	139	173	207
1939	97	109	135	170	
1940	101	110	136	166	
1941					

*Indices for 1910-29 in Mich. Tech. Bul. 130, Table 4, p. 14.

**Indices of prices received for farmers for food, prices paid by farmers for the same food items, and the cost of marketing or distributing food from the farm to the consumer. Published in *Farm Economics* by the Department of Agricultural Economics and Farm Management, New York State College of Agriculture.

***U. S. Bureau of Labor Statistics Index of wholesale prices of food products.

****Weekly earnings of New York factory workers, June 1914 = 100.

**Fig. 2. Index numbers of prices received by farmers for food, retail price of food and cost of distributing food, 1914-40.**

When the price level fell in 1920-22 and again in 1929-32, the cost of distributing food declined less than the retail food prices. Farmers were affected unfavorably since they received a smaller proportion of the lower retail prices.

During the last three major wars, violent inflation has occurred—followed in each case by a long period of deflation.

Farm Food Prices, Retail Food Prices and Distribution Costs

The spread between farm food prices and retail food prices is represented by distribution costs. These costs include the expenses of assembling, grading, processing, packaging, packing, transporting, storing, financing and distributing the food products—between the farm where produced and the final consumer. Because the supply and demand factors which determine food prices are focused primarily in the retail market, the farmers tend to receive what is left of retail prices after the costs of distribution have been deducted.

The distribution costs rose less rapidly than retail prices during the inflation period of World War I. Consequently, farmers received a larger share of the higher retail prices and were relatively prosperous (Table 3 and Fig. 2). However, when deflation occurred in 1920-22, distribution costs remained rigid or inelastic and farmers received a smaller share of the lower retail prices. The relatively high distribution costs during the past two decades has been an important factor responsible for the low level of farm prices. One of the principal items in distribution costs is wage rates, which have been in recent years about double the 1910-14 level.

In 1940, the farm prices of food were about the 1910-14 level, while retail food costs were two-thirds higher, and wage rates twice as high as in the base period. The relatively high distribution costs were partly responsible for farmers in the United States obtaining, on an average, only 42 per cent of the consumer's dollar in 1940.

Michigan Farm Prices and Farm Cost Items

Prices Paid for Commodities Bought—Indices of prices have been prepared for six groups of commodities which farmers buy for production purposes, and for five groups which they buy for family living purposes (Table 4). These two series are combined into an index usually called "prices paid by farmers." During 1940, prices paid averaged 23 per cent higher than in the pre-war base period.

Ratio of Prices Received to Prices Paid—The price position of farmers is frequently estimated by dividing the index of prices received by the index of prices paid to obtain the ratio index or percentage. Inasmuch, during deflation, farm prices decline more rapidly than prices paid, the ratio index was 60 for Michigan farmers in 1932—that is, farm products had 40 per cent less purchasing power in terms of commodities bought than they did in the base period, 1910-14 (Table 5).

As shown by the ratio index, Michigan farmers have been in a better price position than the average farmer in the United States since 1930. The Michigan farmers have had relatively favorable near-by markets, and have not produced many of the low-priced surplus products which have been sold in foreign markets.

Michigan Farm Wages, Taxes and Interest Payments—Farm wages in Michigan declined to low levels during the depression and unemployment period, 1931-36 (Table 6 and Fig. 3). Monthly wages were about 23 per cent higher in 1940 than in 1910-14.

Table 4. Index numbers of prices paid farmers for commodities bought to be used in production and in family living in the United States, 1929-41.*

Year and Month	Feed	Farm machinery	Fertilizer	Building material other than for house	Equipment and supplies	Seed	All commodities used in production	Food	Clothing	Operating expenses	Furniture and furnishings	Building materials—house	All commodities used in family living	Combined production and living
1910-14.....	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1924-28.....	141	153	125	161	139	183	146	153	181	129	193	171	161	154
1929.....	145	153	130	159	136	185	147	149	177	127	188	170	158	153
1930.....	132	152	126	155	131	174	140	137	167	122	179	166	148	145
1931.....	93	150	115	139	116	152	122	109	142	110	153	149	126	124
1932.....	69	141	99	126	107	102	107	90	115	103	128	134	108	107
1933.....	79	137	96	129	103	95	108	95	114	102	126	138	109	109
1934.....	110	144	104	146	109	140	125	108	131	106	136	155	122	123
1935.....	111	148	102	145	108	154	126	120	126	106	136	153	124	125
1936.....	115	149	96	146	110	141	126	116	125	106	135	154	123	124
1937.....	127	154	102	156	115	192	135	120	131	109	142	164	128	131
1938.....	91	158	100	148	114	158	125	108	136	108	137	155	122	123
1939.....	95	155	100	148	110	131	123	108	124	106	135	156	120	121
1940.....	100	153	97	149	110	130	125	108	126	105	136	159	121	123
1941.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1939—March.....	89	157	100	148	113	131	122	105	124	107	135	155	119	120
June.....	92	154	100	147	109	131	121	106	122	106	134	156	119	120
September.....	100	154	99	147	109	130	124	114	123	108	134	156	122	122
December.....	99	154	99	148	109	130	124	107	125	105	135	157	121	122
1940—March.....	103	154	98	148	108	134	125	108	126	106	136	157	121	123
June.....	102	152	98	147	109	134	125	110	125	104	135	157	121	123
September.....	96	153	96	150	110	125	123	107	125	105	136	159	121	123
December.....	100	153	96	153	111	125	125	108	127	105	138	164	122	123
1941—March.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	123

*Indices for 1910-28 in Mich. Tech. Bul. 139, Table 5, p. 17. A few changes have been made in the indices since the previous study was published.

Table 5. Index numbers of Michigan farm prices, United States farm prices, prices paid by farmers for commodities bought, ratio of prices received to prices paid for Michigan and for the United States, 1929-41.*

Year and month	Michigan farm prices	U. S farm prices	Prices paid by farmers	Ratio of prices received to prices paid**	
				Michigan	U. S
1910-14	100	100	100	100	100
1924-28	154	146	154	100	95
1929	165	146	153	108	95
1930	144	126	145	99	87
1931	94	85	124	76	70
1932	64	65	107	60	61
1933	73	70	109	67	64
1934	89	90	123	72	73
1935	104	108	125	83	86
1936	120	114	124	97	92
1937	132	121	130	101	93
1938	102	95	122	83	78
1939	97	93	121	81	77
1940	106	98	122	87	80
1941					
1939—March	98	91	120	82	76
June	92	89	120	76	74
September	107	98	122	88	80
December	107	96	122	88	79
1940—March	108	97	123	88	79
June	103	95	123	84	77
September	108	97	122	85	80
December	118	101	122	97	83
1941—March	112	103	123	91	84
June					
September					
December					

*To supplement Table 5, p. 8, Farm Prices and Costs in Michigan. A reprint from Mich. Exp. Sta. Quarterly Bul. 30, (2), Nov. 1937.

**Frequently called the index of buying power of farm products. Calculated by dividing the indices of farm prices by the index of prices paid by farmers.

Table 6. Monthly wages paid Michigan farm laborers and index numbers of Michigan farm wages, 1910-41.* (March, 1910-14 = 100.)

Year and month	Weighted average	Index numbers	Year and month	Weighted average	Index numbers
1910-14	\$28.18	100	1939—January	\$30.00	106
1924-28	47.86	170	April	33.10	117
1929	40.01	174	July	34.80	123
1930	41.16	146	October	34.95	124
1931	30.28	107	1940—January	30.70	109
1932	21.74	77	April	33.30	118
1933	18.84	66	July	35.65	126
1934	21.91	78	October	35.85	127
1935	25.70	90	1941—January	33.70	120
1936	29.98	107	April		
1937	36.98	131	July		
1938	33.58	119	October		
1939	33.62	119			
1940	34.55	123			
1941					

*To supplement Table 6, p. 9, Farm Prices and Costs in Michigan. A reprint from Mich. Exp. Sta. Quarterly Bul. 30, (2), Nov. 1937.

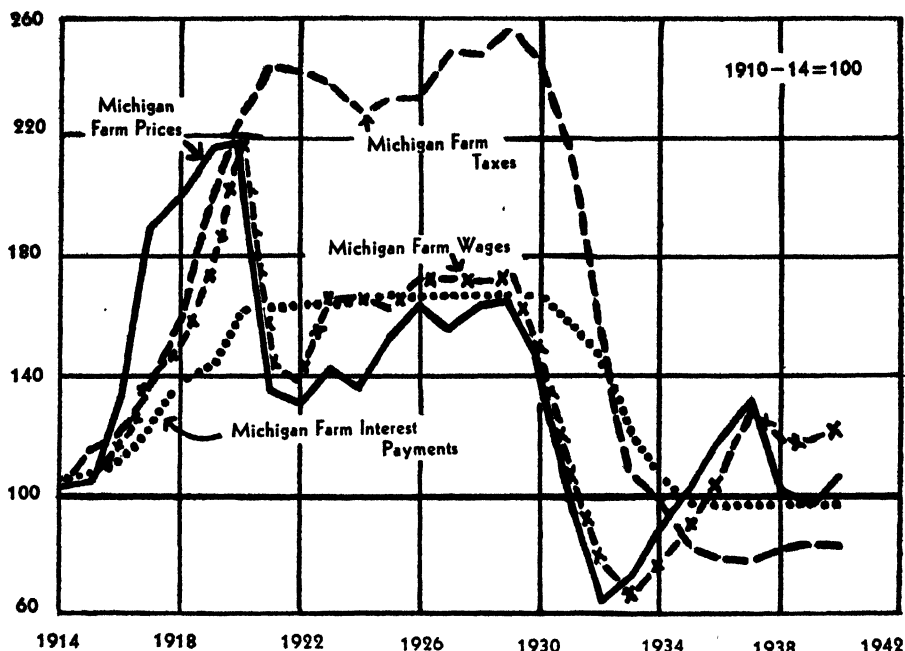


Fig. 3. Index numbers of Michigan farm prices, taxes, wages, and interest payments, 1914-40.

Farm prices rose more rapidly than the cost items of taxes, wages and interest payments during the World War I, but declined more rapidly in 1920-22 and 1929-32.

Table 7. Michigan farm real estate tax per acre and index numbers of farm prices, farm wages, farm real estate taxes, farm mortgage interest payments, and farm real estate values per acre, 1910-40.*

Year	Farm prices	Farm wages	Real estate taxes		Farm interest payments	Farm real estate values
			Tax per acre	Index number		
1910-14.....	100	100	\$0.54	100**	100	100***
1924-28.....	154	170	1.29	238	167	131
1929.....	165	174	1.38	256	167	124
1930.....	144	146	1.34	247	167	121
1931.....	94	107	1.18	218	157	115
1932.....	64	77	.85	158	147	97
1933.....	73	66	.58	107	120	80
1934.....	89	78	.53	98	106	82
1935.....	104	90	.45	83	97	83
1936.....	120	107	.43	80	97	84
1937.....	132	131	.42	78	97	91
1938.....	102	119	.44	81	97	92
1939.....	97	119	.45	83	97	92
1940.....	106	123	.45	83	97	91
1941.....						

*To supplement Table 7, p. 10, Farm Prices and Costs in Michigan. A reprint from Mich. Exp. Sta. Quarterly Bul., #9, (2), Nov. 1937.

**1913 = 100.

***1912-14 = 100.

Real estate taxes reached high levels during the twenties but were adjusted downward rapidly during 1931-35 by retrenchments and as a result of the 15-mill limitation amendment in 1932 (Table 7 and Fig. 3). The state and federal governments have assumed a larger share of the costs of highways, schools and relief. The real estate tax has not been excessive for most farming communities in Michigan in recent years.

The interest payments by farmers were also adjusted downward during the depression and deflation which began in 1929 by repayment of loans, by debt adjustments and by lowering of the interest rates to farmers.

Michigan Farm Cost Index—An index of farm costs was prepared by combining the indices of prices paid for farmers for commodities used in production, farm wages, farm taxes and farm interest payments . . . on the basis of the relative importance of these items as farm expenditures (Table 8). The index of farm costs was considerably higher than the index of prices paid during the twenties, but was lower during most of the thirties. The farm cost index was 15 per cent above the 1910-14 level in 1940.

Table 8. Index numbers of prices of Michigan farm products, Michigan farm costs and ratio of farm prices to farm costs, 1910-40.*

Year	Farm prices	Farm costs**	Ratio of farm prices to farm costs	Year	Farm prices	Farm costs**	Ratio of farm prices to farm costs
1910-14.....	100	100	100	1934.....	89	109	82
1924-28.....	154	167	92	1935.....	104	109	95
1929.....	165	171	96	1936.....	120	111	108
1930.....	144	160	90	1937.....	132	121	109
1931.....	94	138	68	1938.....	102	114	89
1932.....	64	113	57	1939.....	97	113	86
1933.....	73	100	73	1940.....	106	115	92
				1941.....			

*To supplement Table 8, p. 10, Farm Prices and Costs in Michigan. A reprint from Mich. Exp. Sta. Quarterly Bul., #2, (2), Nov. 1937.

**The index of farm costs was constructed by combining the indices of prices paid for commodities used in production (466), farm taxes (140), farm wages (150), and farm interest payments (85).

Ratio of Michigan Farm Prices to Farm Costs—The relative economic position of Michigan farmers can be obtained by dividing the index of farm prices by the index of farm costs (Table 8 and Fig. 4). This ratio index showed an unfavorable farm situation in Michigan during 1921-35 and 1938-40, and a favorable situation in 1936-37 compared with 1910-14 as the base period.

Prices of Groups of Farm Products

Although the prices of all the groups of farm products declined during 1929-32, cash and feed crops fell to the lowest levels (Tables 9-13). The recovery since has brought a more rapid advance in the prices of livestock and their products than in the cash and feed crops.

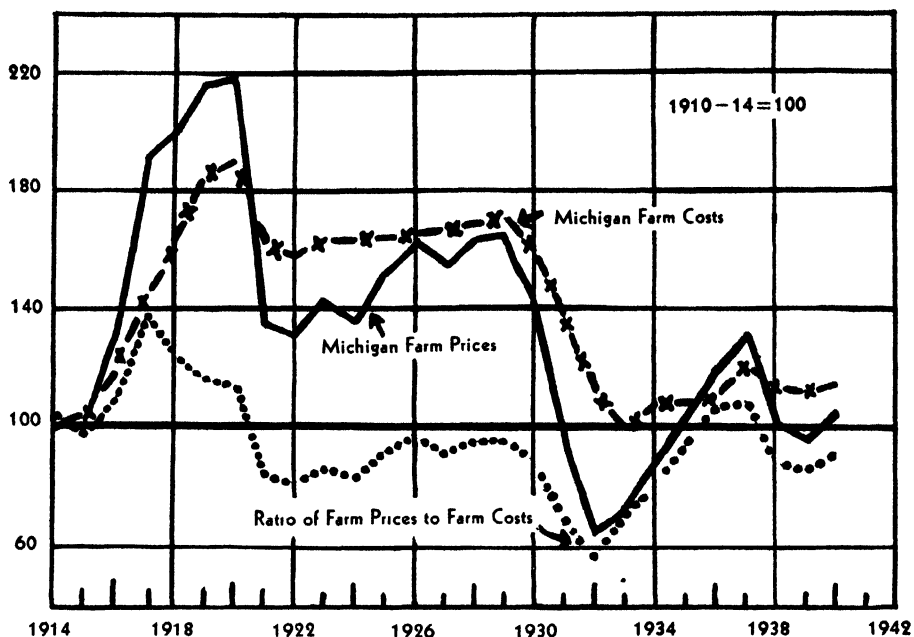


Fig. 4. Index numbers of Michigan farm prices, farm costs and the ratio of farm prices to farm costs, 1914-40.

Considering the period before World War I as a base, farm costs have been relatively higher than farm prices, except during 1916-20 and during 1936-37.

Table 9. Index numbers of farm prices of Michigan cash crops, 1910-41* (1910-14 = 100) (wheat, rye, beans, potatoes, apples, clover seed).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14.	101	102	102	103	105	105	112	113	106	98	96	99	100
1924-28.	166	168	167	174	178	177	176	175	151	151	160	165	163
1929	166	178	172	160	159	159	162	218	203	213	207	190	179
1930	188	185	171	171	178	179	165	164	168	146	129	122	162
1931	121	119	114	118	115	114	104	96	75	58	64	60	87
1932	56	56	57	57	55	56	68	51	52	49	44	43	51
1933	46	47	50	62	77	74	115	132	121	88	88	89	76
1934	99	111	108	102	100	103	102	108	113	91	85	88	99
1935	90	80	89	95	89	89	86	86	80	81	80	82	79
1936	85	89	88	93	100	124	160	172	155	147	152	163	126
1937	177	198	191	189	177	179	164	127	103	95	87	91	138
1938	95	93	91	87	92	91	104	77	73	71	72	81	81
1939	78	80	78	81	90	85	87	82	99	88	89	99	81
1940	104	108	108	115	114	109	114	98	98	95	99	101	102
1941	99	94	97										

*To supplement Table 9, p. 11, Farm Prices and Costs in Michigan. Mich. Agr. Exp. Sta. Quart. Bul., 20, (2), Nov. 1937.

**Table 10. Index numbers of farm prices of Michigan feed crops, 1910-41*
(1910-14 = 100) (corn, oats, barley, alfalfa hay).**

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14.....	97	99	100	102	105	107	106	102	99	99	98	98	100
1924-28.....	115	116	115	112	116	120	118	113	106	108	108	111	110
1929.....	108	115	115	110	108	109	106	101	102	107	106	106	109
1930.....	106	106	104	107	106	102	93	101	117	119	116	115	106
1931.....	112	106	102	101	100	91	78	70	67	65	67	68	88
1932.....	64	62	60	60	59	56	51	48	47	45	43	41	53
1933.....	41	41	42	47	54	55	70	66	66	64	66	66	56
1934.....	71	76	81	86	89	99	105	127	137	135	129	132	101
1935.....	120	131	126	122	116	107	75	61	60	61	56	58	95
1936.....	57	59	56	57	57	61	74	92	96	96	98	102	76
1937.....	108	111	109	111	114	108	96	73	76	74	72	75	93
1938.....	77	76	75	73	69	67	66	56	55	60	61	60	67
1939.....	61	62	62	62	66	65	60	56	66	66	60	74	65
1940.....	76	77	81	80	78	72	66	58	66	62	66	66	71
1941.....	71	69	69										

*To supplement Table 10, p. 12, Farm Prices and Costs in Michigan. A reprint from Mich. Agr. Exp. Sta. Quart. Bul., 20, (2), Nov. 1937.

Table 11. Index numbers of farm prices of Michigan meat animals and wool, 1910-41* (1910-14 = 100) (cattle, calves, hogs, sheep, lambs, wool).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14.....	99	99	98	99	103	102	101	103	104	101	97	95	100
1924-28.....	141	145	146	149	147	147	149	152	155	154	147	146	149
1929.....	160	165	171	171	175	169	173	170	161	159	149	151	163
1930.....	154	156	153	145	137	138	125	123	126	120	116	109	133
1931.....	112	108	106	107	101	93	93	94	91	84	76	71	93
1932.....	70	69	70	69	60	59	71	70	68	62	58	56	64
1933.....	55	59	59	57	66	70	71	70	70	77	65	59	61
1934.....	63	75	75	71	70	68	71	72	82	78	72	73	72
1935.....	94	103	115	115	118	120	118	128	131	129	123	125	118
1936.....	128	129	126	127	123	126	125	129	129	124	120	125	126
1937.....	135	131	134	136	137	142	144	156	153	141	125	117	137
1938.....	118	113	121	116	113	118	123	117	119	114	118	112	116
1939.....	117	118	120	116	113	109	114	110	126	118	114	107	115
1940.....	112	111	110	109	114	109	116	118	119	119	117	117	113
1941.....	130	132	131										

*To supplement Table 11, p. 13, Farm Prices and Costs in Michigan. A reprint from Mich. Agr. Exp. Sta. Quart. Bul., 20, (2), Nov. 1937.

**Table 12. Index numbers of farm prices of Michigan poultry products, 1910-41*
(1910-14 = 100) (chickens, eggs).**

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14.....	127	119	104	92	92	93	94	97	106	112	120	128	100
1924-28.....	199	178	143	143	145	144	148	156	169	183	213	224	156
1929.....	186	186	177	150	156	161	165	179	177	202	216	221	169
1930.....	194	174	137	136	129	119	122	129	140	148	157	141	169
1931.....	125	104	107	109	93	95	98	103	113	118	133	121	102
1932.....	99	84	75	74	70	69	77	84	89	111	124	127	79
1933.....	100	64	62	63	67	56	93	87	96	116	128	116	89
1934.....	87	88	83	82	78	74	75	89	107	113	134	124	87
1935.....	122	131	105	114	121	117	115	121	141	146	155	152	123
1936.....	124	138	117	108	112	113	116	122	124	137	171	148	116
1937.....	119	107	112	117	104	100	112	119	134	145	155	141	118
1938.....	130	105	105	102	109	110	113	118	131	144	151	138	113
1939.....	107	99	100	96	83	87	96	104	111	120	133	99	97
1940.....	88	105	91	91	87	82	92	99	112	124	137	128	97
1941.....	103	97	97										

*To supplement Table 12, p. 14, Farm Prices and Costs in Michigan. A reprint from Mich. Agr. Exp. Sta. Quart. Bul., 90, (2), Nov. 1937.

**Table 13. Index numbers of farm prices of Michigan dairy products, 1910-41*
(1910-14 = 100) (milk, butterfat).**

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14.....	115	110	103	96	85	83	86	94	101	109	118	120	100
1924-28.....	168	166	163	158	150	147	150	153	158	163	165	171	158
1929.....	176	174	178	167	162	155	155	162	165	173	170	161	165
1930.....	145	140	136	141	136	126	128	138	150	145	138	126	137
1931.....	114	105	106	104	92	83	89	99	106	109	100	98	99
1932.....	86	78	76	71	68	64	64	69	71	69	71	74	71
1933.....	71	66	64	65	72	74	87	82	86	87	89	80	77
1934.....	75	87	92	89	88	90	92	101	99	99	108	110	94
1935.....	113	124	114	119	102	92	94	98	101	108	115	124	107
1936.....	127	130	118	116	108	108	122	130	132	131	131	132	122
1937.....	134	132	134	131	125	120	120	125	132	136	145	150	137
1938.....	136	122	122	114	104	99	101	103	105	107	108	114	111
1939.....	108	105	101	94	91	92	94	98	103	114	119	122	102
1940.....	120	122	117	113	110	106	106	112	112	119	124	138	115
1941.....	127	124	124										

*To supplement Table 13, p. 15, Farm Prices and Costs in Michigan. A reprint from Mich. Agr. Exp. Sta. Quart. Bul., 90, (2), Nov. 1937.

THE GRADE AND CONDITION OF SOME COMMERCIAL PACKS OF MICHIGAN APPLES IN MID-WINTER

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Observations in several cities during the past fall and winter showed that some apple packs from Michigan were of poor quality because of (a) careless grading, (b) bad bruises and decay developed subsequent to grading in the packing house, or (c) both careless grading and subsequent development of bruises and decay. The problem appeared to be serious enough to justify the careful grading of a few random packs and then showing the packers of these containers how their fruit graded out compared with packs of other packing houses in the same producing district.

Inspectors of the State Department of Agriculture obtained 26 random-selected bushel packs from seven storages of packing organizations in Berrien and Van Buren counties during the week beginning Jan. 6, 1941. Those from two concerns were shipped by railway express to the State Department of Agriculture at Lansing. The other lots were delivered from the respective storages to the State Department of Agriculture in inspectors' cars. During the latter part of that week, all lots were shipped by truck to the Department of Horticulture at Michigan State College where they were opened and graded on January 11.

Five individuals of the Department of Horticulture staff graded the apples under the general supervision of one individual but there were unquestionably some inconsistencies in interpretations. What may be interpreted as 33 per cent color by one individual may appear to be less than that amount to another. The graders attempted to establish a definition of bad bruises but again this is a matter of judgment and judgments are prone to differ at times.

The name of the packer, the designated grade and minimum size, and the kind of container and pack were recorded for each container before grading was attempted. In the process of grading, each individual apple was examined carefully and classified for: "within grade," below grade for color, under designated minimum size, bad bruises and skin breaks, decay, and below grade for other reasons, including excess scab, excess numbers or sizes of stings, excess russetting, badly misshapen fruits, and similar designations. The fruits were then counted and the number in each classification was recorded.

Table 1 shows the grade-out record for each of the 26 containers and Table 2 the grade-out record for each shipper included in the study.

Table 1. Actual grade-out records for 26 packed containers of Michigan Apples.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Designated grade	† F.	F.	No. 1	No. 1	No. 1	F.	F.	F.	No. 1	F.	No. 1	No. 1	No. 1	F.	F.	No. 1	F.	F.	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1
Minimum size declaration	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½
No. apples in container ..	132	125	171	145	144	132	134	141	167	157	166	149	170	101	119	143	141	99	110	153	116	100	100	159	87	99
Percentage below grade for:																										
Size	0	11	5	2	0	18	13	0	16	14	3	5	8	2	6	1	10	6	13	0	0	2	5	7	1	0
Color	0	18	10	0	5	8	1	0	7	12	11	0	5	6	4	0	15	6	3	3	5	2	9	2	0	18
Other defects	0	10	24	11	2	12	5	2	3	9	19	2	24	18	12	4	7	17	22	20	38	0	12	27	0	0
All defects at pack- ing time*	0	32	38	13	7	35	19	2	25	36	33	7	35	24	22	6	32	30	35	22	42	4	26	34	1	18
Bruises and skin breaks (%)	39	8	4	55	1	2	4	64	9	9	5	4	5	12	19	50	6	8	6	2	11	65	13	6	56	51
Decay (%)	0	0	0	1	0	2	1	1	0	2	0	1	0	1	0	0	1	1	0	0	4	2	10	1	0	0
Total postgrading defects* (%)	39	8	4	56	1	4	4	66	9	11	5	5	5	13	19	50	7	9	6	2	16	67	23	7	56	51
Total off-grade* (%)	39	38	41	69	8	39	23	68	34	47	37	11	41	37	40	55	39	38	41	24	58	71	47	38	57	70

† F.=U. S. Fancy.

*Additions may not appear to be correct because (1) some fruits had more than one defect and (2) all percentage figures are rounded to nearest whole number.

Table 2. Actual grade-out records for 7 commercial packers of Michigan apples.
(Based on 3 to 4 containers each.)

	Code letter for individual packers							
	A	B	C	D	E	F	G	Average
No. apples in container.....	561	564	634	645	410	360	286	3,460
Percentage below grade for:								
Size.....	1	14	5	7	7	6	1	6
Color.....	0	9	5	6	6	8	7	6
Other defects.....	4	8	14	17	17	20	0	12
All defects at packing time*..	5	31	23	29	29	32	8	23
Bruises and skin breaks (%)....	52	6	4	5	10	13	58	18
Decay (%).....	1	1	0	0	3	1	1	1
Total postgrading defects* (%).....	53	7	4	5	13	14	59	19
Total off-grade* (%).....	58	37	27	34	41	45	66	42

*Additions may not appear to be correct because (1) some fruits had more than one defect and (2) all percentage figures are rounded to nearest whole number.

Eleven of the packs were designated as U. S. Fancy and the others as U. S. No. 1 grade. All packs were of the Delicious variety except Lots V, Y, and Z, which were of Northern Spy. One bushel was packed with a minimum size of 3 inches, nine bushels with a $2\frac{3}{4}$ -inch minimum designation, and the others were labeled minimum size $2\frac{1}{2}$ inches. There were two tub-type bushel baskets (C and M) and four corrugated cardboard containers with double walls (A, H, D, and P). All other lots were packed in the so-called eastern box (11 x $12\frac{1}{2}$ x 16 inches) by what is generally designated as the "face and fill" method. The walls of these boxes were lined with cardboard and either corrugated caps or cushions were used on tops and bottoms of packs. The cover for each box consisted of four $\frac{1}{8}$ by $2\frac{3}{8}$ -inch strips. Individual apples in the face of packs V, Y, and Z were wrapped. Most of the packers had tried to get just enough bulge to hold apples firmly without seriously bruising them.

All figures in Tables 1 and 2 below the line "No. apples in container" are percentages. The sub-totals and totals marked with asterisks may be greater or smaller than the actual totals for figures in the columns. This is largely because an apple might be sub-grade on two or more counts, such as being under the designated minimum size, sub-grade in color, and badly bruised. Such an apple was designated as being below grade for each of these items but in the sub-totals and totals it is counted as one fruit. Furthermore, all percentage figures in the table are rounded to the nearest whole number.

Size and Color Deficiencies

The federal specifications for apple grades permit a tolerance of 5 per cent for size. This means that not more than 5 apples in 100 may be smaller than the minimum size declared by the packer. Eleven of the 26 packs exceeded this tolerance and the average percentage of apples failing to meet declared size grades was 6 per cent (see Table

2, last column). Two packers (Table 2, A and G) packed well within the size tolerance and another (C) averaged just under the tolerance. On the other hand, the packs of one plant (B) graded 10 to 18 per cent undersized apples. Obviously, in this case, the sizing machine was not properly adjusted. Half of the packs of three of the seven packers exceeded the size tolerance.

In each case, the apples were sized by machine prior to packing. No machine, when operated under commercial conditions, can be infallible in sizing apples. However, if a machine is properly adjusted and if it is not operated at excessive capacity, the numbers of undersized apples that are delivered to respective bins should be well within the specified tolerance. This tolerance is permitted to take care of unavoidable inaccuracies of mechanical equipment. It is not intended that equipment may be adjusted to permit a few undersized apples to go into each pack.

Minimum color requirements for varieties and grades are specified very definitely but human eyes must be relied upon to estimate whether each apple has sufficient color to meet the minimum requirements for Fancy or for No. 1 grades and this must be done while the fruits are rolling past the sorter at rates of perhaps 100 to 150 per minute. It is, therefore, unreasonable to assume that no undercolored specimens will be found in a commercial pack. Yet, approximately one-half of the

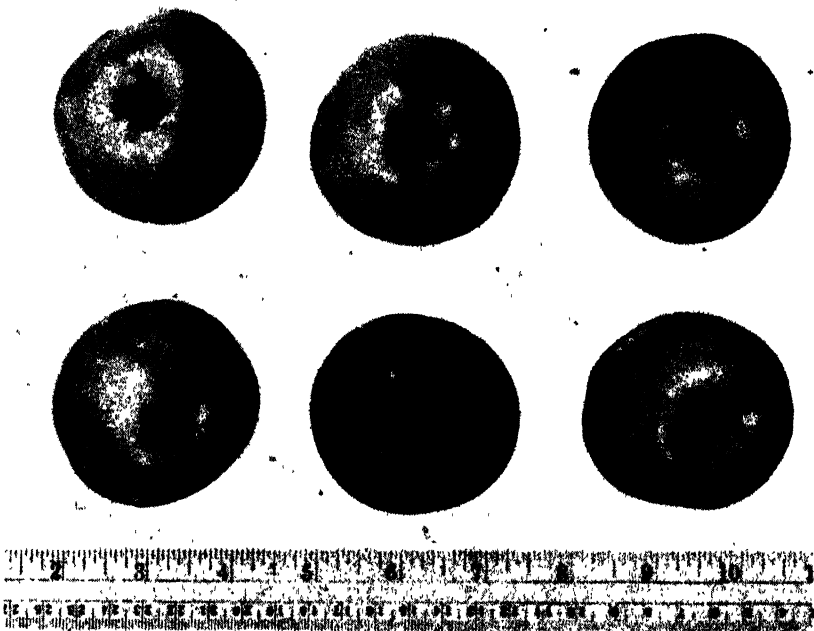


Fig. 1. Only two of the seven commercial packers supplying apple packs for this study were well within the size tolerance of 5 per cent. Seven of the 26 bushels available for the study contained more than two times as many apples below the declared minimum as are permitted in the federal standards.

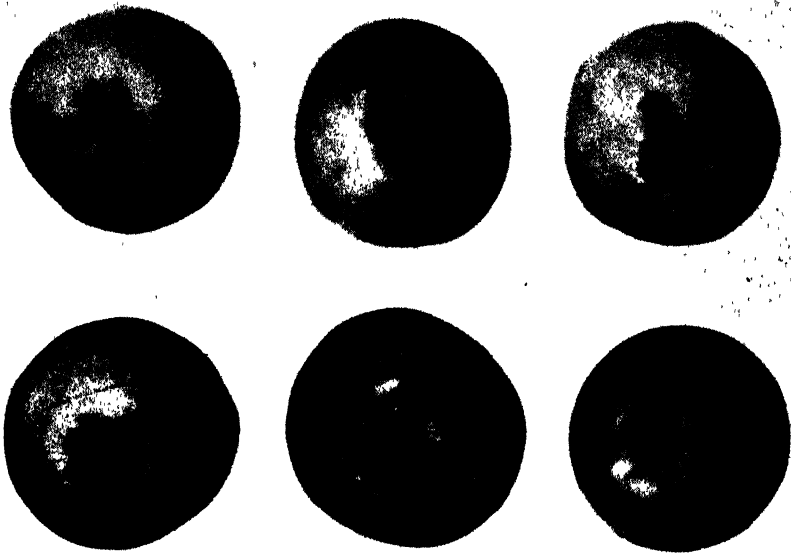


Fig. 2. Apples packed U. S. Fancy or U. S. No. 1 must not have corked-over scab spots having a total or aggregate area of more than $\frac{1}{4}$ -inch in diameter. Nearly one-half of the containers available for this study contained enough apples with excess amounts of scab to exceed the total tolerance allowable for all defects other than lack of size. Two of the seven packers, however, packed all containers well within the tolerance for such defects.

packs under consideration had fewer than 5 per cent undercolored fruits. On the other hand, 8 of the 26 packs exceeded 10 per cent undercolored apples, which is the total tolerance allowed for all apples under grade for any reason except undersize.

Grade Deficiencies Other Than Size and Color

"Other defects," as listed in tables 1 and 2, included stings, scab, seriously deformed fruits, and excess russeting. More than 10 per cent of the fruits in 50 per cent of the containers were defective in this classification. One box (U) had 38 per cent of its fruits below the standards specified for U. S. No. 1. This was mostly scab that was evident at the time of grading. In some cases, the stings were too large to be permitted in the grades and in some others more than two stings were found on fruits. Apples were designated as being seriously deformed when it was considered that a commercial paring machine would not remove most of the peel.

Inasmuch as the designated tolerances are for all defects other than size, the percentages for "color" and for "other defects" of Tables 1 and 2 should be combined to determine the proportion of packs that were within the designated grades and their tolerances. Only 9 of the 26 packs would come within the grades and allowed tolerances, and only 2 of the 7 packers were packing according to the intended stand-

ards. At the time the packs were made, an average of about 18 per cent of the apples were below grade compared with an allowable tolerance of 10 per cent.

Bruises and Skin Breaks

The foregoing discussion has dealt with defects which were evident at the time of grading and packing. Bad bruises and skin breaks that were found on fruits in these containers are assumed to be "incident to proper handling and packing," though it is likely that a few of them may have been present at the time of grading. It is, therefore, incorrect to state that any one of the lots of apples under consideration was undergrade because of bruises and skin breaks. Nevertheless, bad bruises and skin cuts detract seriously from the appearance of the apples in the market and either of them makes conditions favorable for development of decay. Thus, a bushel of apples may meet all grade specifications but be a very inferior lot of fruit because of bruises and cuts resulting from packing operations and subsequent handling. Lots A and Y of Table 1 are excellent examples.

Tables 1 and 2 show very wide ranges in amounts of bruising. Some containers that had been packed with high percentages of sub-grade apples survived storage and arrived at shipping destinations with very few bad bruises or skin breaks (Table 1, C, F, and T), while the apples of several lots were badly bruised and were very disappointing to their shippers as well as receivers.

Lots A, D, H, P, V, Y, and Z of Table 1, and A and G of Table 2 were shipped by railway express from shipping points to Lansing while

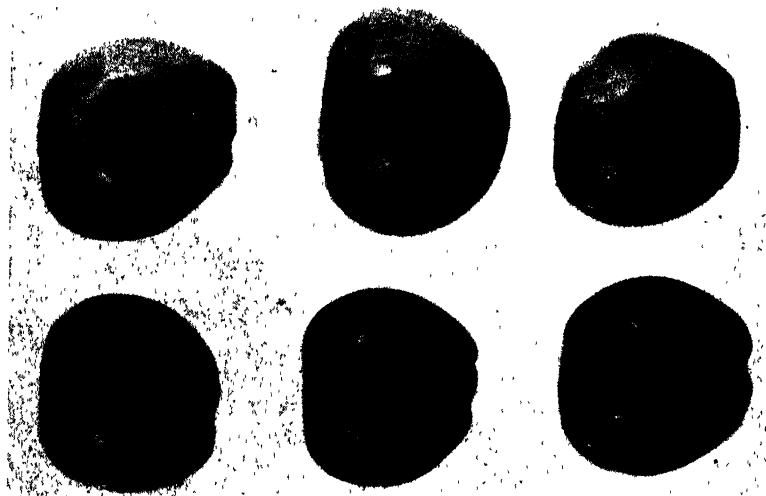


Fig. 3. Most of the apples with bad bruises were found in the middle portions of the containers. Apples in the face layer of most packs were relatively free from serious bruising. Large apples bruised more seriously than those of medium size.

other lots were transported in inspectors' cars. Fifty-four per cent of the apples shipped by express were badly bruised or skin-punctured compared with 7 per cent for those transported by automobiles. The great amount of bruising in some of these lots was partly due to the fact that four of the seven containers were corrugated cardboard boxes and the jumble pack apples were loose on arrival at destination. Again, the other three of the seven bushels consisted of Northern Spy apples while all others were Delicious. The conditions of this test were such that it is not possible to determine just how much of the bruising was due to variety, how much to method of transportation, nor how much to the container.

Apples of large size seemed to be more subject to serious bruising than smaller ones. The percentage of badly bruised apples in the $2\frac{3}{4}$ -inch packs ranged from 6 to 65 per cent with an average of 11 per cent while the $2\frac{1}{2}$ -inch packs ranged from 1 to 9 per cent with an average of 5 per cent.

Apples in the face layer of most packs were conspicuously freer of bruises than other fruits. This was particularly true when the apples in the face were wrapped. Most of the bruised apples were found in the middle portions of the containers. This leads one to question the advisability of the face and fill pack for the larger apples of certain varieties.

Thirteen of the 26 bushels were free from decay at the time of examination. On the other hand, 10 of the 100 apples in one bushel showed active decay. The average for all the lots was slightly less than 1 per cent decay.

Conclusions

Only a few of the packs of seven of the great number of packers of apples in Michigan were studied and it is not claimed that these packs were representative, were poorer, or were better than the average for the state.

The foregoing data are presented to give the packers of Michigan apples some conception of the condition of these apples after some 80 to 90 days storage and transportation. Some of the containers may have been subjected to very rough handling and some of them may have been handled carefully subsequent to packing. The data warrant two rather definite conclusions: (1) that some of the fruit that is packed in some of our better known packing houses has not been graded carefully enough to enable it to meet the grade specifications and permitted tolerances, and (2) that there should be a change in methods of packing the eastern box so as to avoid serious bruising in this container if it is to become the dominant one for packed apples.

A PRELIMINARY EXPERIMENT UPON BONING, CURING, SMOKING, AND COOKING TURKEY MEAT

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SECTIONS OF POULTRY HUSBANDRY AND CHEMISTRY

In recent years, there have been surpluses of turkeys which are too large for small or medium-sized families. If these turkeys were boned, they could be easily cut to order for any size family. If precooked, such a product could be sliced by machine and used as sandwich filling or as cold meat. If cured and smoked, they would be preserved more satisfactorily and would appeal to a type of market as yet unexploited. Obviously, boned turkey would require considerably less space during cold storage because of the elimination of inedible material.

A method for curing and smoking turkey carcasses has been developed by Schaible, Davidson and Sykes (1) and common boning procedures recently have been reviewed by Schaible and Davidson (3). Fresh smoked turkey roll has been reported by Treat (2). The present study was made to adapt the curing and smoking method to boned turkey and to develop means for precooking the smoked product.

Experimental Procedure and Observations

Seven hen turkeys approximately 28 weeks of age which had been reared in confinement on the college poultry farm were used in this study. They were killed, dry-picked, drawn and boned. The boning was done as follows: The tendons were pulled, using an ordinary hook, shanks removed and wings cut off at the second joint. The skin was slit along the backbone, and the backbone was sawed through. The flesh and skin were peeled off together, using a boning knife to ease the flesh from the skeleton in one piece. The legs and wings were pulled from the outside in, so as to remove the remaining tendons. The meat was rolled from the two sides to make a double roll and held by skewers while it was tied with cord to hold the roll in shape.

Curing: The rolls were "stitch-pumped" with the curing brine. Six rolls were immersed in salt solution for 24 hours, and one for 12 hours. The latter proved too short a time. The processing was done in a local meat packing plant and the packer's solution for curing hams was used.

Cooking: All of the rolls were cooked in the individual ham cookers used by packing plants. These pans have covers that shut tightly so that no substances escape. Three rolls were cooked 18 minutes to the pound in boiling water and four were cooked 28 minutes to the pound in the same manner. Those cooked 18 minutes were "under done" and those cooked 28 minutes were well done. It is probable that cooking time will vary with the age and quality of the bird.

Smoking: The cooked rolls were placed in a viscose ham casing and smoked 6 hours at 160° F. in hardwood smoke. Six hours was judged insufficient, although it had proven sufficient where ham stockinettes had been used on drawn uncooked turkeys (1). Apparently the casing is more impervious to the smoke than the skin and the inner membranes surrounding the visceral cavity of the bird. It is probable that 8 to 12 hours will give sufficient smoke flavor. The casing produced a much more desirable looking package.

Data

A record of the weight of the turkeys at various stages is given in Table 1. The weight of the processed meat amounted to 45.8 per cent of the undrawn dressed weight of the birds. The giblets and meat remaining on the skeleton might have been utilized in the production of canned soup. Meat remaining on the skeleton was determined by cooking and weighing the cleaned skeleton; some loss of soluble materials from the skeleton is included in this weight.

Table 1. Shrinkage data in pounds.

Weight	Turkey number*							Average percentage of	
	1	2	3	5	7	8	9	Live weight	"Blood-and-feather" weight
Live.....	15 6	14 0	13 2	15 2	12 8	16 1	13 5		
"Blood-and-feather" dressed	14 6	12 8	12 1	14 0	11 8	14 9	12 5	92 3	
Drawn (neck and giblets not included)	11 5	10 1	9 4	11 2	9 2	11 6	9 9	72 6	78 6
Boned.....	9 2	7 9	7 3	8 7	7 2	9 2	7 7	57 0	61 7
Meat recovered from skeleton.	1 5	1 2	1 1	1 3	1 1	1 1	1 2	8 5	9 2
Cured, precooked and smoked	6 9	5 9	5 4	6 5	5 2	7 1	5 5	42.3	45.8

*Turkeys were treated as follows: Numbers 1 and 8 were cured 24 hours, cooked 18 minutes per pound; numbers 2, 4, 5 and 9 were cured 24 hours, cooked 28 minutes per pound, and number cured 12 hours and cooked 18 minutes per pound.

Table 2 gives comparative prices per pound, assuming 25 cents per pound as a basis for "blood-and-feather" dressed turkeys. The fresh boned price assumes that enough will be obtained for the giblets to pay the cost of boning, which is not unreasonable to expect. The boned, cured, smoked and cooked price is based on the assumption that 2 cents per pound would cover the cost of processing.

Table 2. Calculated prices (in cents) per pound. Comparison of fresh, boned, and processed turkey.

Bird number.....	1	2	4	5	7	8	9
"Blood-and-feather" dressed.....	25	25	25	25	25	25	25
Fresh boned*.....	30	40	41	40	40	40	40
Boned, cured, cooked, smoked**.....	55	56	58	56	59	55	59

*Giblets assumed to pay cost of boning.

**Two cents per pound allowed for processing.

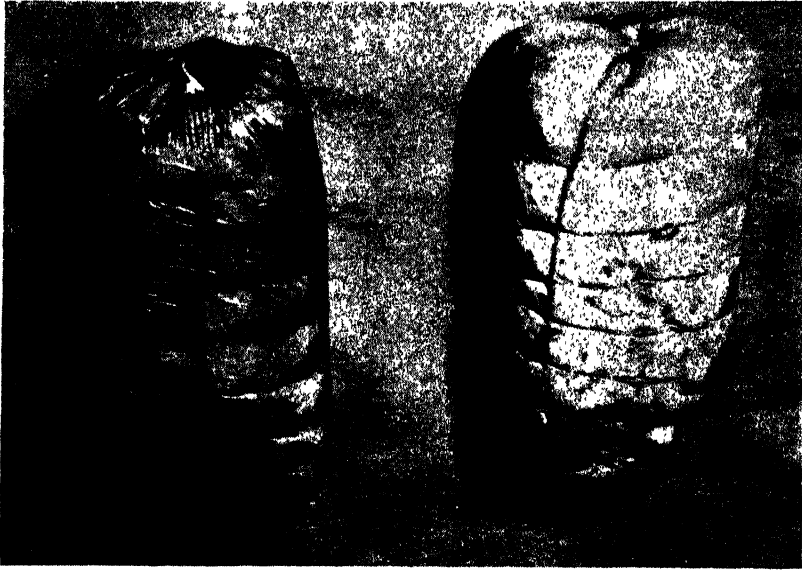


Fig. 1. Boned, cured, smoked turkey rolls. The one on the right has casing removed.

Summary

A procedure for producing precooked, smoked turkey roll has been outlined. It is believed that this product offers a feasible means of utilizing some of the surplus larger turkeys to the extent of opening up untouched outlets for turkey meat. The price that would have to be obtained for the product is not beyond the range of competitive lines from other sources.

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MARKETING HUSKED SWEET CORN

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SECTION OF HORTICULTURE

As a fresh market vegetable, sweet corn has never achieved the importance it deserves. Although it is one of the most popular home garden crops, the volume consumed by the average urban family is relatively small, even though the price the grower receives often does not justify its production.

Among the reasons for the lack of consumer interest in fresh sweet corn, poor quality is undoubtedly paramount. At summer temperatures the sugars in corn rapidly change to starch and the delightful flavor is soon lost. This loss of quality can be greatly retarded by refrigeration, but because of the large volume involved owing to the husks, corn is seldom cooled before moving to market or held in a refrigerator at the points of wholesale or retail distribution. The effective insulation provided by the husks makes the rapid cooling of freshly harvested corn difficult.

Next to lack of quality, the housewife's reluctance to purchase more fresh sweet corn appears to be due to the frequent presence of corn borer or earworm larvae. Even though injury is confined to the tip of the ear the very presence of a "worm" often stifles interest in the epicurean aspects of the corn itself, regardless of its appearance or flavor when it reaches the table. Too often much of the corn has to be discarded or excessively trimmed owing to larval damage and the purchaser feels cheated even though the price may have been ridiculously low. The likelihood of frequent purchases throughout the season is thus reduced.

Much consumer resistance to buying sweet corn is due to the corn's immaturity or over age. Unless it is carefully selected by the consumer much of the corn received is likely to be too "old" or too "young" to suit most tastes.

The time required for preparation is often a deciding factor in the consumer's choice of a vegetable; it takes but a few seconds to open a can of corn but minutes are required to husk and silk even a few ears. The labor involved places a definite limitation on the use of fresh sweet corn in restaurants where the tendency is to keep the amount of help needed at a minimum by using many canned and frozen products.

The writer has long felt that these hindrances to greater consumption of fresh sweet corn might be largely eliminated if a means of marketing a product already husked and silked could be devised. Husked corn lends itself readily to rapid cooling and refrigerated storage during transportation and marketing. Borer and earworm larvae continue to feed after harvest, and their activity can be stopped by husking and cleaning as soon as the ears are picked. Frequently earworms are

still in the silks when the corn is at its prime, or at most only the tip of the ear has been injured. If allowed to remain in the husks at room temperatures for as much as 24 hours they may have eaten their way a considerable distance down the ear.

Preparation for Market

An investigation of the possibilities of marketing husked sweet corn was conducted during the summer of 1940. Although the test was limited in scope the great interest shown in the product and the thought that market gardeners might find the method worth a trial prompted this preliminary report.

"Cellophane" bags were first tried but were soon discarded in favor of a "Cellophane" package as shown in Fig. 4. After being husked, silked, and trimmed to uniform length a triangular stack of six ears is made on a sheet of "Cellophane" cut to the necessary length from a roll 20 inches wide (Fig. 3). This is a standard width for roll "Cello-



Fig. 1. Husking corn on the plant. To keep the ears clean, harvesting should be done when the plant is dry. Paper-lined baskets should be used as shown in Fig. 3.



Fig. 2 Trimming. The tips should be removed as well as the silks and pieces of husks.

phane" and a 20-inch sheet is sufficient for wrapping six ears of most hybrids and open-pollinated varieties now grown for market purposes. The package is wrapped by bringing first one edge and then the other over the top ear and then folding the ends in a triangular manner to conform with the stack of corn. The package is then sealed with a strip of cellulose "Scotch" tape extending from one end along the side where the two edges overlap and across the other end.

It was found that considerable labor could be saved by husking the corn on the stalk rather than to harvest in the usual way and husk later. The method employed is illustrated in Fig. 1. While a portion of the husks are stripped down with one hand the other is used to pull the silks and the balance of the husks away from the cob. The ear is then grasped with the first hand as close to the butt as possible and broken out by bending downward.

In order to keep the corn as clean as possible baskets used in the field were lined with paper, as shown in Fig. 2. It was found that if harvested when the stalks were dry, little dirt, such as the dried portions of the silks, clung to the husked ears. Although washing was practiced with some of the corn marketed, this extra operation adds considerably to the expense involved and seems unnecessary if care is exercised in keeping the corn clean in the field and packing shed.

The corn was then trimmed with a sharp knife; the rough butts

were cut off and pieces of husk wedged between the rows of kernels were removed (Fig. 2). Three lengths were packed and the tips were cut off to whatever extent necessary to fit the ears to one of the length grades. All poorly filled tips and all that were damaged by earworm, borer, or smut were removed. Frequently ears showing considerable worm damage could be used in the smallest length grade after removal of the injured portion. Silks were removed by hand, although towards the end of the season it was found that a medium stiff brush could be used to speed up the desilking. It has been suggested that rubber gloves are also an aid in removing silks.

Economic Considerations

Towards the end of the season records of the time required for the various operations were kept. On several successive days it was found that one man could prepare from 10 to 12 packages per hour including all steps from harvesting to wrapping and placing in cartons ready for delivery. At 35¢ per man hour this labor involved a cash outlay of from 3¢ to 3½¢ per package of six ears. In addition, the "Cellophane" and cellulose tape cost approximately 1¢ per package. No doubt greater speed could be attained on a larger scale of operations so the total cost would not exceed 4¢ per package.

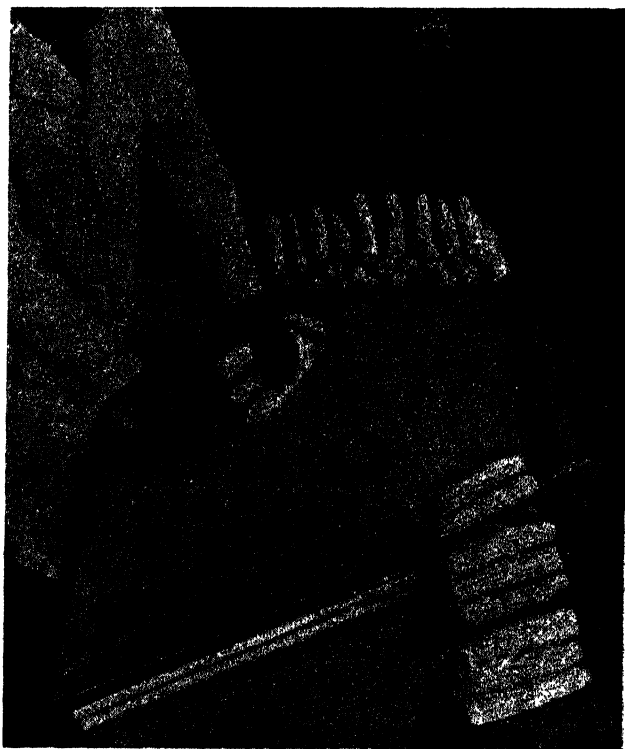


Fig. 3. Wrapping. Six ears are placed in a triangular stack, wrapped in "Cellophane," and sealed with cellulose tape.

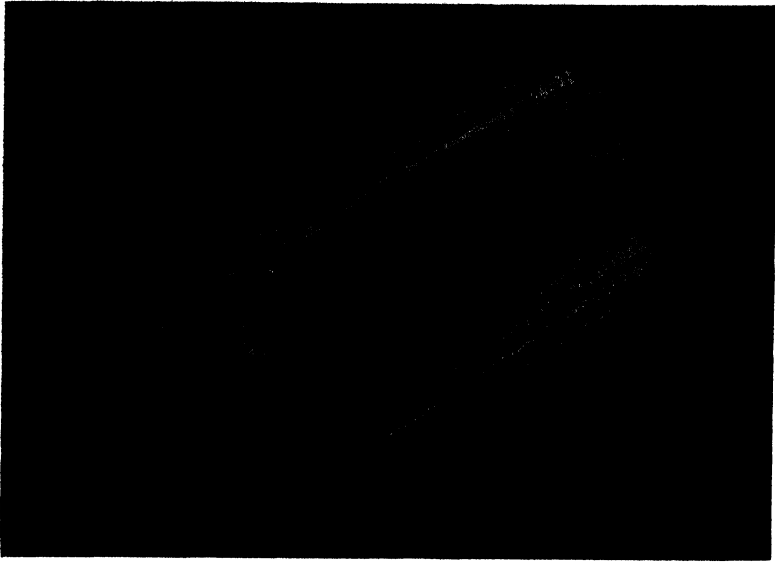


Fig. 4. The finished package ready for market.

The packages of six ears retailed for a minimum of 15¢ except for some of the smallest sizes which retailed for 12¢. During the period the packages retailed for 15¢, the grocer handling the corn was retailing good quality corn in the husk for 15¢ per dozen, exactly half as much per ear. At the Lansing market, corn could be purchased during this same period for as low as 10¢ per dozen. Still, few persons objected to the price of the husked corn and the demand exceeded the supply available from the college plots. Although the cost of preparing husked corn for market is such that it would necessarily have to sell for more than ordinary corn, this premium could be proportionately lower as the retail price increased.

During much of the season the corn was sold to the grocer for 12¢ per package for the longer grades which constituted most of the crop. If growers had a cost of 4¢ per package for harvesting, preparation, and materials they would realize 1¢ per ear in the field even though the product wholesaled for only 10¢ per package of six. This is a fair return on sweet corn, which will often yield approximately 10,000 marketable ears per acre on fertile soil and with ample moisture, provided, of course, that there is not excessive insect damage* and that productive varieties or hybrids are planted.

The grocer handling the corn was especially enthusiastic about this method of marketing because his losses were reduced to a minimum. So often a sizable proportion of corn purchased for resale is unmarketable and the grocers' profits are cut to almost nothing. Each customer tends to pick out the better ears and at the end of the day only those of inferior appearance remain. Often these ears have some worm

*For methods of controlling the corn earworm and the European corn borer, the reader is referred to his County Agricultural Agent or the Department of Entomology, Michigan State College.

damage near the tip which could have been readily removed had the corn been husked and packaged on harvesting. Because of the difference in probable losses the merchant who handled the packaged corn was very willing to retail it with a 20% mark-up while at least a 30% margin was considered essential with corn in the husk.

It was found very convenient to place corn harvested and packaged in the afternoon in a refrigerator until delivery the following morning. Moisture condensed inside the "Cellophane" to some extent but this did not seem to hurt materially the sales appeal of the package. Much of the condensed moisture again evaporated when the package was allowed to warm to room temperatures. Although the corn retailed in this test was all sold on the day of delivery there is no reason why any packages left over could not have been placed in a refrigerator overnight and sold the following day.

Packaged corn kept refrigerated was eaten as long as 10 days after harvest and found to be equal in quality to much of that found on city markets. Such a long period of storage is not to be recommended but if properly refrigerated there is no reason why corn should not remain on sale for a period of two or possibly three days. Longer periods should be unnecessary if growers have a continuous supply available and merchants do not overstock. Some highly perishable vegetables such as lettuce are now kept in refrigerators in retail stores only enough being removed at a time for display purposes. Such a practice would be highly desirable with sweet corn, especially that which is not likely to be sold the same day it is received by the merchant.

A western New York grower has shipped a considerable volume of corn to New York City with the ears husked, thoroughly cleaned, and wrapped individually in a parchment paper. The corn thus marketed is cooked and served in the parchment. This product was received very favorably by the restaurant and hotel trade. The cost of the parchment wrappers is about $\frac{1}{3}$ cent each when purchased in small quantities so the total cost of preparation for market would be somewhat higher than that for the "Cellophane"-wrapped product.

No doubt the demand for corn prepared for cooking and wrapped in "Cellophane" or parchment paper will be largely confined to those retail markets where consumers are not unduly limited in their food budgets. The restaurant trade should also be a good outlet for such a product. It appears very probable that the consumption of fresh sweet corn would increase if a high quality "ready-to-cook" corn had wide distribution. From the growers' standpoint it seems very likely that the per acre returns might materially increase if corn was marketed in this way, and at the same time profitable labor might be created for the grower and his family.

It would be especially important for producers trying this method of marketing to deliver a high quality product at all times and, insofar as possible, to encourage proper handling by the retail merchant. "Cellophane"-or parchment-wrapped corn would soon acquire a bad reputation if a poor quality product found its way to market. A daily delivery service to stores would be ideal and it would be to the interest of both the grower and merchant not to market corn after the second or possibly the third day even though it had been refrigerated.

Care should be taken in harvesting not to allow the corn to get too old. It is impossible to avoid some variation in the stage of maturity; perhaps the best way to solve this problem is to include ears of slightly varying stages in one package, as frequently the tastes of persons in the same family will differ with respect to the maturity preferred.

Equipment now used by commercial canners and freezers of whole ear corn could be successfully used to eliminate much hand labor. Machines are available for husking, silking, trimming to uniform length, and washing. No doubt aids in wrapping such as heat sealing of the "Cellophane" could also be employed. Owing to the cost of such equipment a large volume would have to be handled but it would no doubt be profitable for a large grower or shipper or for an association of growers.

Recommended Varieties

In recent years several very desirable hybrid sweet corn varieties have been developed which, for canning purposes, have virtually replaced the open-pollinated varieties such as Golden Bantam, Country Gentleman, and Stowell's Evergreen. Many market gardeners now plant only hybrids; the better ones give a larger number of ears per acre and mature the crop more uniformly, thus reducing the cost of harvesting. In addition, the ears of hybrid corn are more uniform in size and shape, which would be a distinct advantage to one marketing husked corn.

Markets in the North now demand only yellow corn equalling or approaching the original 8-rowed Golden Bantam in quality. There are excellent 8-rowed hybrids available; however, markets in Michigan generally prefer corn of larger diameter. On the basis of tests at the College plots and the experiences of numerous market gardeners the following high quality hybrids having from 10 to 16 rows of kernels are recommended for use by growers serving Michigan markets:

Early: Marcross C6-13, North Star

Second Early: Tendergold, Bancross P 39, Kingscrost J9

Main Crop: Golden Cross Bantam

Late: Ioana

There are many other golden hybrids offered by the seed trade which are undoubtedly good; it is suggested that growers test them carefully before planting extensively. A few extra early hybrids which will mature a few days before those classed as early in the above list are available; however, among those tried the ears were small, the yield low, and the quality inferior. If planted at all, such a variety should be used to fill only the demand during the few days of the harvesting season until the somewhat later varieties become available.

Because of greater uniformity with respect to time of reaching marketable condition a given planting of hybrid sweet corn will furnish prime ears over a shorter period than most open-pollinated varieties. When using hybrids it is very important for growers wishing to market a succession of corn to plant ones that mature on successive dates and also to make repeated plantings. It is suggested that one early hybrid, one or perhaps two from the second early group, and Golden Cross Bantam be used. Seed of each of these

should be sown at the time of the first planting and then repeated sowings of Golden Cross Bantam should be made to supply quality corn up until frost. Golden Cross Bantam is of especially high quality and gives very good yields, compared with the earlier varieties, so it should constitute the bulk of the crop. Ioana, which matures a few days later than Golden Cross Bantam, is being used in its place to some extent particularly for canning purposes, but tests at the Michigan Station indicate that it is not of so high quality for fresh use.

METHODS OF RAISING COLTS ECONOMICALLY

L. H. BLAKESLEE AND J. E. BREWSTER
SECTION OF ANIMAL HUSBANDRY

With horse prices at the present low level, farmers are faced with the necessity of raising colts as economically as possible in order to be able to market them at a working age and still show a profit.

The Michigan State College conducted a series of experiments over the last 10 years involving the raising of colts from the time they were weaned until they were of working age.

The first project was conducted on a group of 24 Michigan draft foals sired by purebred draft stallions. These colts were divided into three lots of eight colts each and were fed experimentally at different planes of nutrition from Dec. 1, 1931 to Feb. 28, 1934. One lot was fed a liberal ration of 2 pounds of grain per 100 pounds weight, the second was fed a conservative ration of 1 pound of grain per 100 pounds weight, and the third was fed a limited ration of $\frac{1}{2}$ pound of grain per 100 pounds weight. The grain allowance was 50 per cent coarsely ground ear corn and 50 per cent oats by weight. The hay allowance was the same for all lots.

From the results of this experiment it was concluded that a limited ration of grain and alfalfa hay with free access to straw does not stunt draft colts but does retard development. A limited ration seems to have a greater effect on weight and condition than on skeletal development. Details as to how the colts were fed are found in Michigan Agricultural Experiment Station Special Bulletin 253.

The second group of 24 colts were weanlings from Dakota range mares and purebred Belgian stallions. These colts were fed from Oct. 13, 1933 to April 1, 1936. The colts were divided into lots and fed similarly to the colts in the project of 1931 to 1934 except that the grain allowance was 57 per cent coarsely ground ear corn and 43 per cent oats; Lot 1 was divided at the beginning of the second winter after being fed a liberal ration the first winter and half of the colts were fed a conservative ration and half a limited ration for the remainder of the experiment. All colts in each group were pastured together during the summer.

Table 1 shows the weights of the colts and the amount of feed each group was fed.

The cost of feed for the various lots of colts with prevailing prices at that time was:

Michigan Colts:*

Lot 1	\$118.05	Liberal ration
Lot 2	87.99	Conservative ration
Lot 3	69.56	Limited ration

Dakota Colts:**

Lot 1A	\$113.86	Liberal ration first winter and conservative ration thereafter.
Lot 1B	102.27	Liberal ration first winter and limited ration thereafter
Lot 2	102.71	Conservative ration
Lot 3	80.05	Limited ration

The colts fed a liberal ration were in higher condition, but the excess flesh did not make them more valuable for work animals than the conservatively-fed colts. Limited-fed colts matured at a later age than colts that had more feed.

At the present time the College has on experiment 28 coming two-year-old Michigan-bred colts sired by purebred draft stallions. The colts were purchased as weanlings and divided into lots on Nov. 15, 1939.

Twenty of these colts are fed in single stalls during the winter. The first winter they were fed one pound of grain and one pound of hay per 100 pounds of weight. They were turned on pasture in the summer and were fed no grain. The second winter they received $\frac{1}{2}$ pound of grain and $1\frac{1}{4}$ pounds of hay per 100 pounds of weight. The grain ration is one-half oats and one-half ear corn by weight. Two other colts are fed the same ration but are never turned on pasture.

There are six colts that have never received any grain but have "made their living" during the winter in a pasture that has a stack of alfalfa hay in it. They are on pasture with the other colts in summer.

At this point the experiment is approaching the end of the second winter and it is difficult to make any definite statements as to the cost of raising colts of different weights. However, there are some general observations that are available.

The colts are not fat but are thrifty and are growing.

The group of colts in the hay lot that have never received any grain were thin at the end of the first winter but came off summer pasture seemingly equally as well conditioned as the grain-fed colts. They have wintered better than the grain-fed colts and are fatter and have made gains comparable to the other colts. The two colts that have never run on pasture have always looked fat and sleek, but they have never been so clean in their hocks and ankles as the colts that have had more exercise and less care.

Suggestions:

Colts can be raised to working age with little expense and labor by feeding less grain and more hay and running in pasture at all times with only a shed for shelter.

When horses are cheap and feed is high it may be advisable to limit the grain ration although the colts will not be quite as fat at maturity.

When horses are high and feed is cheap, a more liberal ration will grow the colts more rapidly and will put them in better condition to sell at any time.

Colts that have been liberally-fed can usually be worked at an earlier age than limited-fed colts.

Good pasture is an economical means of raising colts and can replace grain entirely during the summer months.

*Ear corn \$0.50 per bu. Oats \$0.36 per bu. Hay \$6.00 per ton. Pasture \$0.35 a wk.
 **Ear corn \$0.70 per bu. Oats \$0.32 per bu. Hay \$8.00 per ton. Pasture \$0.35 a wk.

GROWING CHICORY SEED

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SECTION OF FARM CROPS

What is Chicory?

Chicory [*Chichorium intybus*, Linn. (chicoriaceae)] is a tall, herbaceous perennial. The first year, as it develops from seed, only a clump of broad leaves and a fleshy taproot are produced. In this stage of growth both tops and roots are similar in appearance to the top and root growth of sugar beets, though the roots are smaller and more slender. In subsequent years the chicory plant grows to a height of 2 to 7 feet, with a coarse stem containing milky juice, numerous spreading branches, and beautiful blue, or sometimes pink or white flowers.

The roots of chicory when dried, ground, and roasted are used as a substitute for or an addition to coffee. In the United States, 10 per cent or more of chicory with coffee is the customary blend. The mixture gives a darker brew with more "body". It holds its pleasing aroma and flavor longer than straight coffee. The flavor is highly regarded, and chicory has held a place of importance as a beverage adjunct for nearly 150 years.

In the United States, chicory was introduced as a commercial crop about 45 years ago and has been grown to some extent in Michigan, Nebraska, Illinois and Wisconsin. The leaves of special varieties are used in salad making. The production of the large-rooted chicory used for beverage purposes has centered in Michigan which grows 95 to 98 per cent of the United States crop. From 6,000 to 8,000 acres are normally grown in this state, principally in the Saginaw Valley and Thumb District.

The Chicory Seed Problem

In the past chicory seed for the Michigan industry has almost all been imported from Europe. Some seed was grown in this state in 1916 to 1919, because the World War I made importations impossible. The experience at that time was very unsatisfactory owing to the use of conventional European methods involving overwintering of the roots in storage and otherwise large amounts of hand labor both in transplanting and harvest. There were also heavy seed losses caused by birds. Seed production was discontinued in Michigan as soon as that war was over.

The threat (in 1937) of another war that would again stop the importation of chicory seed from Europe occasioned a new study of the problem. There was in Michigan at that time seed enough for only one or two crops. It takes two seasons from planting to the first setting of seed. Accordingly, a study of methods of chicory seed production which might be suitable under Michigan conditions was undertaken by the Farm Crops Section of the Michigan Agricultural Experiment Station at East Lansing.

Chicory Plants Overwintered in Field

One of the major expenses encountered in the European method of growing chicory seed is that of digging first year chicory roots in the fall, overwintering them in storage, and transplanting the roots in the seed-producing field the following spring. Because wild chicory appeared entirely winter-hardy in Michigan, it was decided to see if the domesticated varieties might not prove equally resistant to winter-killing.

To test this theory, two plantings were made. The first of these was on May 6, 1938, on a soil varying from sandy loam to clay loam in a reasonably good state of productivity. One end of the area was low and, though tile-drained, subject to flooding for short periods. This land was fitted, fertilized with 400 pounds to the acre of complete fertilizer and sown to barley. Immediately on completion of the barley seeding the chicory seed was planted.



Fig. 1. Seeding chicory in the spring with grain is an economical way of establishing a stand for seed production. This chicory was planted on May 6, 1938 with barley and photographed late in September the same season.

This seed was drilled in 21-inch rows at the rate of about 2 pounds an acre. The purpose of the barley was merely to get a crop from the land that season, thereby greatly reducing the cost of establishing the chicory stand. No blocking or thinning of the chicory was intended and none was done. This field was about one-half acre in size.

Another field of one-half acre was seeded on May 7, 1938—this one a light sandy loam soil. In this field the chicory was seeded exactly as in the barley field but oats, cut green for hay, were used as the companion crop.

The chicory came up satisfactorily but made very little growth while the grain crops were still on the field,—apparently because of competition of the grain for water. The lack of vigor of the chicory was particularly apparent on the sandier soil and on areas of the heavier soil where barley lodged. However, there was no loss of stand, the chicory made a moderate growth

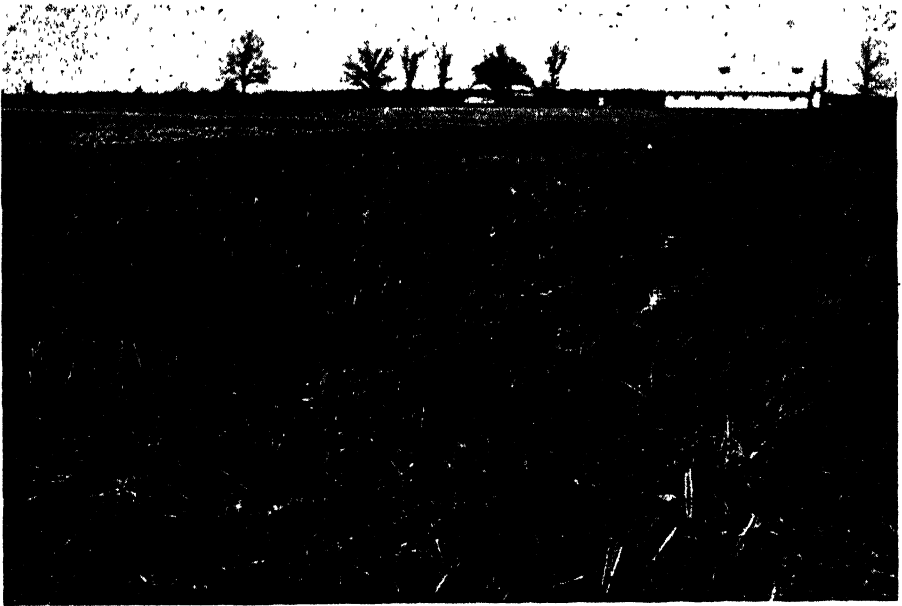


Fig. 2. Chicory is winter-hardy. Note the new growth showing in the barley stubble. Photographed May 10, 1940, one year after planting.

after the grain was removed and, most important of all, survived the winter in both fields with no noticeable loss of stand whatsoever.

Chicory in another field, seeded with barley in 1939, likewise produced an excellent stand of plants and survived the winter perfectly.



Fig. 3. Three cultivations are usually necessary to control weeds. Long grain stubbles and trash interfere with good cultivation and are not necessary for winter protection of chicory. The grain crop grown as a companion to a new chicory seeding should be cut with a binder leaving as little stubble as possible.

Culture and Harvest

The overwintered chicory roots sprouted in late March, were not noticeably affected by alternate freezing and thawing in March and April, and soon developed a large enough top growth so that, in early May, the grain stubble was cultivated out. This was followed by two later cultivations and one hoeing to control weeds. In the later stages, weeds had little chance because of the vigorous and dense growth of the chicory. Culture, therefore, was simple and inexpensive.

The chicory developed rapidly as the season advanced until the plants were in bloom, a mass of blue flowers. Flowering started in mid-June and continued indeterminately with heaviest blossoming occurring during the first ten days of July. In early August there were ripe seeds, flowers and young buds on each plant. A small amount of ripe seed shattered but losses were negligible. The time when the most ripe seed could be obtained was a matter of personal judgment. The crop was cut August 15. Figs. 5 and 6 show some chicory still in bloom at harvest time.

Because the chicory was planted in 21-inch rows, it was necessary to cut it with the grain binder. A few rows planted 28 inches apart were cut very satisfactorily with a corn binder. This feature alone makes the 28-inch rows preferable, for the corn binder could be operated much more easily than the grain binder. However, by elevating the platform of the grain binder as high as possible and removing the reel and windboard, a clean job of cutting was done. The binder was tractor drawn. Where the chicory growth was



Fig. 4. A good stand is essential to a high yield. Note the good stand of new growth at the base of the old chicory stubble. This field yielded 384 pounds of clean seed per acre in 1939. Photographed May 10, 1940. The 1940 seed yield was 241 pounds an acre. Much of the difference was due to losses by shattering and sprouting owing to 9 inches of rain which fell during the period the chicory was in the shock. In 1939 shattering losses were negligible.



Fig. 5. Chicory can be harvested with a grain binder but a corn binder which is made to handle larger and heavier material, is more satisfactory. Photographed August 15, 1940.

light, four 21-inch rows could be cut at once, but where the growth was rank the quantity of material from four rows was too great to go up the elevator. In this heavy growth only two rows could be cut at a time and an extra man was necessary to keep the chicory falling on the platform properly so it would go up the elevator.

Reports from Europe indicate that the seed crop there is harvested by hand and the bundles are wrapped in cloth to save the shattered seed. In neither 1939 nor 1940 was shattering severe enough in the East Lansing crops to warrant such a procedure. There was some shattering of seed in the shock in 1940, owing to more than 9 inches of August rainfall which delayed threshing. Inasmuch as this rainfall set an all-time August record at East Lansing, the 1940 situation cannot be regarded as typical. Normally, in Michigan, August presents very favorable weather for the harvest of any crop.

The bundles were set up in shocks and dried satisfactorily. In any reasonable weather, this final drying presents no particular problem because the chicory branches are stiff and prevent extremely tight binding. Thus, air freely circulates through the shocked material. Observations of material grown for seed from transplanted roots indicate that the unthinned closely spaced crop grown at East Lansing was much easier to handle and stood up better than the tangled, low-branching material grown from the more widely spaced transplants, and also gave better seed yields.

Threshing was done with an ordinary grain separator. The air was almost but not entirely shut off. Because adjustments of concaves and screens vary with the make of the thresher, they are not described here. Any experienced thresher operator can readily adjust his machine to handle this crop. Considerable dust and chaff remained with the seed as it came from the separator but the dirt and light seeds were effectively removed by running

the seed twice through a farm-sized fanning mill. The larger-sized cleaning mills equipped with screen brushes undoubtedly would have been more efficient in cleaning the seed.

More Than One Seed Crop Secured from Same Stand

Inasmuch as chicory is a perennial, the stands harvested for seed in 1939 were left undisturbed following removal of the crop. A new leaf growth soon started from the crown and the plants again survived the winter. There was some winter-killing but it seemed to be confined entirely to the larger roots. It was noted, when spring growth started, that from one to five stalks developed from each living root. This increase in number of seed stalks per plant seemed to offset the slight loss by winter-killing, and the number of seed stalks to the acre appeared as great the second year as the first. Figs. 4, 5, and 6 are of chicory producing its second seed crop.

The cleaned seed yields secured at East Lansing without special treatment were as follows:

Area 1: 1939—Chicory seeded in barley in 1938 on dark loam soil....	384 lb. an acre
Area 1: 1940—Second seed crop from this stand.....	241 lb. an acre
Area 2: 1939—Chicory seeded in oats in 1938 on sandy loam soil....	267 lb an acre
Area 2: 1940—Second seed crop from this stand.....	107 lb. an acre
Area 3: 1940—Soil similar to Area 1; chicory seeded in 1939 with barley.....	262 lb an acre

Considering the low cost of these production operations and the prices which have had to be paid for imported seed, even in normal times, these seed yields are more than ample to justify domestic seed production. By producing its own seed the chicory industry also may find it feasible to develop varieties especially suitable for the environment under which the commercial crop is grown rather than depending on remote sources for varieties. At times there are also opportunities for seed export.



Fig. 6. High yield and low cost per pound of seed are the result of good agronomic practices. A field like this is capable of producing about 400 pounds of clean seed to the acre.

Effects of Nitrogen on Chicory Seed Production

The original fertilization of the chicory land at the time the crop was seeded with grain provided only a small quantity of nitrogen. A limited trial was conducted in 1939, and repeated on the same plats in 1940, to determine the effects of nitrogen on seed yields. This experiment was carried on on the sandy loam soil. Results are given in Table 1.

Table 1. The effect of ammonium sulphate on the seed yield of chicory.

Amount of Ammonium Sulphate Used (pounds per acre)	Yield of clean seed (pounds per acre)	
	1939	1940
0.....	267	107
200.....	341	118
400.....	347	93
600.....	369	65

From the data in Table 1, it is apparent that under certain conditions too much nitrogen can inhibit seed production. In 1939, there was a definite and profitable response to the application of 200 pounds an acre of sulphate of ammonia. The yield increases from the larger applications were not significant. In 1940, the response to the 200-pound application was not significant, but the second applications of 400 and 600 pounds an acre definitely reduced seed yields. Further studies are needed to interpret these results.

Until such studies have been made it seems entirely reasonable to apply both phosphorus and, on the lighter soils of Michigan, potash liberally when the chicory stand is being established. This can be done by drilling in 300 to 400 pounds an acre of 0-20-0 on heavy soil, 0-14-6 on medium loams, and 0-20-20 on sandy loams. No nitrogen is suggested for the original application in order to avoid undue stimulation of vegetative growth of the grain with resultant increased competition with the chicory seedlings for moisture. Each year thereafter that the stand is used for seed production an application of not to exceed 200 pounds an acre of ammonium sulphate, made as a top-dressing in April, should be safe and frequently very profitable.

Desirable Cultural Conditions

Chicory seed is a crop of high acre value suitable for intensive culture. Well-drained silt loams, clay loams, and the heavier sandy loams in a good state of fertility should give best seed yields. The lighter sandy soils will give lower seed yields unless unusually well supplied with organic matter and well fertilized.

Fields containing persistent perennial weeds such as Canadian thistle, field bindweed, perennial sow thistle and quack grass should be avoided. Ordinary annual weeds may be controlled by thorough seedbed preparation and cultivation. In an established stand of good vigor, weed control practices, cultivation and hoeing, will be required early in the spring. Later, the dense vigorous growth of the chicory is unfavorable to any competing growth. Weed control for this crop is not difficult if the noxious perennials are avoided. Cultivation should not be necessary the year the stand is established in small grain.

The chicory seedbed should be firm and in fine tilth. The disk, spring- and spike-tooth harrows, cultipacker, and float are useful in getting the land in shape.

Chicory, if planted without a grain crop, may be sown anytime from early spring to mid-summer. In Michigan, as a regular procedure there seems to be no good reason for any other practice than that of seeding the chicory with small grain. Thereby, the only cost of establishing the stand is the actual cost of the chicory seed plus the labor of drilling it into the ground.

Two or three pounds of seed an acre sown in 28-inch rows are sufficient. The seed should be sown $\frac{1}{4}$ to $\frac{1}{2}$ inch in depth. This necessarily shallow planting emphasizes the need for a fine, firm seedbed.

How to Grow Chicory Seed

First Year—Select a well-drained field free from noxious perennial weeds. A medium to moderately heavy loam soil in good state of fertility is preferred.

Prepare a clean, fine and firm seedbed as early in the spring as possible. As seedbed preparation is being completed, drill in 300 to 400 pounds an acre of commercial fertilizer: heavy soils, 0-20-0; medium soils, 0-14-6; sandy loam soils, 0-20-20.

Sow the field to oats or barley at a normal rate of seeding.

Drill the chicory seed in immediately after the small grain is planted, using 2-3 pounds of chicory seed in 28-inch rows and covering it to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inch. The chicory requires no further attention that year. Do not block or thin the crop.

Harvest the grain with a binder, cutting as low as convenient to leave a minimum amount of stubble. Do not harvest it with a combine leaving the straw and long stubble in the field. The grain may be cut for hay or silage when green and this is especially desirable if serious lodging occurs.

Second Year—Top-dress the chicory in early April with 100 to 200 pounds an acre of ammonium sulphate. Cultivate the grain stubble and any other material out from between the rows of chicory as soon as possible in the spring.

Repeat inter-row cultivations as may be necessary to control weeds.

Hoe weeds out of the rows if necessary.

Harvest when most of the seed is ripe. (This will probably be from early to mid-August.) There would still be some flowers even if harvest were delayed until frost.

Cut with a corn binder tying medium-sized sheaves. A grain binder may be used but it is less convenient.

Shock the sheaves in round shocks held together with binder twine.

Thresh the seed crop, when dry, with a grain separator adjusted for light seed.

RESULTS OF STRAWBERRY PLANT SPACING EXPERIMENTS

R. E. LOREE
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Studies on the yield of strawberry varieties as influenced by different spacing treatments were begun at East Lansing in 1937. Five varieties, Premier, Senator Dunlap, Fairfax, Dorsett, and Catskill, were selected for the experiment. The plants were grown in a fertile, well-drained soil. A heavy clover sod was turned under previous to the preparation of the land for strawberries, which provided an abundance of organic matter. No commercial fertilizer was used the first year, but at the time of renewing the bed after harvest, a 4-16-4 fertilizer was applied at the rate of 500 pounds per acre.

The plots consisted of one 100-foot row of each variety trained according to the single hill, single hedge-row, spaced row, and matted row systems. The hill plants were set 12 inches apart and all others at intervals of 24 inches in rows spaced 4 feet apart. In the single hedge-rows, two runners from each plant were trained in line with the mother plant to form a single continuous row of plants spaced 8 inches apart. In the spaced rows, the runners were trained so that the young plants were rooted at intervals of 4, 6, and 8 inches. All

Table 1. Yield of strawberries in quarts per 100-foot row as influenced by system of training and plant spacing. Approximately 1/100 acre.

First year—1938

System of Training	Variety				Average of all varieties
	Fairfax	Dunlap	Catskill	Dorsett	
Single hill, plants 12" apart	13	30	23	26	23
Single hedge-row, plants 8" apart	12	40	19	15	21
18- to 24-inch spaced row, plants 8" apart	19	58	47	32	39
18- to 24-inch spaced row, plants 6" apart	14	58	48	27	37
18- to 24-inch spaced row, plants 4" apart	19	72	44	16	38
18- to 24-inch matted row	17	48	46	25	26

Second year—1939

Single hill, plants 12" apart	29	52	31	20	33
Single hedge-row, plants 8" apart	25	51	35	31	35.5
18- to 24-inch spaced row, plants 8" apart	60	84	90	49	73
18- to 24-inch spaced row, plants 6" apart	67	79	95	48	72
18- to 24-inch spaced row, plants 4" apart	73	79	90	34	68
18- to 24-inch matted row, fall-thinned	62	67	77	32	60
18- to 24-inch matted row, not fall-thinned	73	57	75	40	61

Table 2. Yield of Premier strawberries in quarts per 100-foot row as influenced by system of training and plant spacing. Approximately 1/100 acre.

First year—1940

Single hill.....	25 quarts
Single hedge-row.....	31 quarts
18- to 24-inch spaced row, plants 8" apart.....	62 5 quarts
18- to 24-inch spaced row, plants 6" apart.....	76 quarts
18- to 24-inch spaced row, plants 4" apart.....	72.5 quarts
18- to 24-inch matted row, unthinned.....	57.5 quarts

surplus runners which formed later were removed by hand. The rows were allowed to develop to a width of 18 to 24 inches. In the matted rows, the runners were allowed to root naturally which resulted in a rather dense mat of plants.

The total yields of the different varieties and the average of all varieties under the different spacing treatments are shown in Table 1. Because of a high mortality of plants, a poor stand of Premier was obtained the first year, and for this reason, data on the variety are not shown in Table 1. However, a good stand of plants was obtained in 1939 and the 1940 yields for the variety are shown separately in Table 2.

The low yields in 1938 as compared with those in 1939 were caused by an advanced plant growth in the spring accompanied by late frosts which damaged or destroyed many of the blossoms. Senator Dunlap, Premier, and Catskill appeared to be less susceptible to frost damage than either Dorsett or Fairfax. The damage was more severe on Fairfax than any other variety. In fact, most of the crop from Fairfax in 1938 was unmarketable either because of frost or unfavorable conditions for pollination. Damage to Dorsett was also severe, but the percentage of unmarketable fruit due to frost was comparatively small. The greater susceptibility of these varieties to frost damage is probably due to the fact that the blossoms are borne on long cluster stems which hold them above the plants, while in the more resistant varieties such as Premier, the cluster stems are short and the blossoms are more or less protected by the leaves. Weather conditions in 1939 were very favorable and large yields were obtained. A warm humid atmosphere during the ripening period resulted in some field rot. This was more prevalent in the more dense matted rows.

Fall Thinning vs. Plant Spacing

There has been some question regarding the value of fall thinning of matted rows. In the fall of 1938, one matted row of each variety was thinned and an adjacent row was left unthinned. Thinning was accomplished by dragging a rake across the rows. This loosened many of the late-rooted runner plants which were pulled to the edge of the row and removed. The yields from the thinned and unthinned rows are shown in Table 1. There are no consistent differences in total yield which would indicate any benefits in favor of this type of thinning. In fact, the yields of some varieties were slightly decreased by the practice and the average yield of all varieties from thinned and unthinned rows was about the same. Presumably, many of the late runners which were not removed by late fall thinning did not have an oppor-

tunity to root, or if so, the root systems were so small that they did not seriously compete with the plants which had become well-established earlier in the season.

Larger Yields from Spaced Rows

Observations and results of this experiment indicate that of the various factors which may influence yields and profits in a strawberry plantation, the following are most important: first, a fertile well-drained soil with an abundance of humus, second, a good stand of plants, and third, a well-spaced plant row. The importance and value of a well-spaced row are demonstrated by the data which are presented. With some varieties, the yield from matted rows was nearly as large as that from spaced rows, but in general, the spaced rows were most productive of marketable fruit. In 1938, the acre yield of Senator Dunlap from spaced rows was 1,000 to 2,400 quarts more than from the matted rows. The differences in yield of other varieties were not large in 1938, but in 1939, the average of all varieties from spaced rows was 1,000 quarts more per acre. With Premier in 1940, the spaced rows produced 500 to 1,800 quarts more per acre than the matted rows.

Development of a Well-Spaced Plant Row

Obviously, the commercial grower with a considerable acreage could not afford the labor necessary to develop the spaced rows as practiced in this experiment. However, he can, by certain cultural practices, develop a well-spaced matted row which will produce large yields of high quality marketable fruit. In order to develop a properly spaced row, the runners should be permitted to spread naturally. When runners begin to form, the cultivated strip between the rows should be reduced in width with each successive cultivation to prevent loosening and throwing the young rooted plants back onto the plant row. Several hoeings are usually necessary and at this time the young runners may be trained and the tips covered with soil where the plants are to become established. In later hoeings, some of the plants may be thinned out, if necessary, to provide a proper distance between them.

The best distance between plants in the row depends on the habit and vigor of the variety. With varieties such as Dorsett, Fairfax, and Catskill, which naturally produce large crowns, a 6- to 8-inch spacing seems to be necessary for best results. On the other hand, with varieties such as Senator Dunlap, which produces many small plants, a 4-inch spacing may be sufficient. With Premier, a distance of 6 inches between plants seems most desirable.

In order to be most effective, strawberry plant spacing should be done relatively early in the season. Properly spaced plants which have become established in the row on or before September 1 are more productive than those which become rooted later in the fall. Late fall thinning, as practiced in this experiment, was neither practical nor profitable. Hill culture or the use of the single-hedge row system of training are not to be recommended for the commercial grower, particularly with the varieties used in this experiment. Hill plants produced large numbers of flower clusters but they failed to set and mature a good crop of large marketable berries.

THE COMPOSITION AND PROPERTIES OF GOATS' MILK

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While the amount of goats' milk sold in Michigan is comparatively small, there is considerable interest in it. Also, there is a need for more information on some of the properties of goats' milk. The Michigan unit of the National Goat Milk Scoring Contest, in which Michigan producers participate, furnishes samples of goats' milk produced in various sections of the state. With these samples at hand, as well as others submitted throughout the year, it seemed advisable to obtain further data beyond those specifically required in the contest. Consequently, analyses were made to determine the percentage fat, solids-not-fat, total solids, ash and titratable acidity; and studies were made on the flavor, bottle and cap, sediment, specific gravity and pH of the samples furnished the laboratory during 1940. In the contest itself the samples were judged according to those terms on the score card as shown in Table 1.

The Composition of Goats' Milk

Voorhies (19) stated that the composition of goats' milk varied as that of cows' milk with the breed, period of lactation, and individuality of the animal. Because many other factors are known to cause a varia-

Table 1. Score card for goats' milk. (American Goat Society, Inc., Lincoln, Nebr.)

Item	Perfect score	Score allowed	Remarks
Bacteria.....	35		Plate count.....
Flavor and odor	25		.....
Visible dirt	10		.....
Butterfat	10		Per cent found
Temperature at delivery...	15		Degrees F.
			Bottle.....
Bottle and cap	5		Cap: Hand or machine set
			Lip protection: Complete, partial or
Total	100		none.....

tion in the composition of cows' milk, it is assumed that factors other than those above mentioned also affect the composition of goats' milk. Some analyses of goats' milk reported in the literature are given in Table 2.

From these analyses it is very evident that the constituents of goats' milk vary markedly as do those of cows' milk. In this respect Jordan and Smith (9) reported as follows: "The range of composition of the mixed milk of the whole flock as determined during May and June of

Table 2. Composition of goats' milk.

Source	Water	Total solids	Solids-not-fat	Fat	Sugar	Proteins		Ash
						Casein	Albumin	
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Richmond (15) quotes:								
Konig (average)	85.71			4.78	4.46	3.20	1.09	0.76
Moser and Soxhlet	86.48			4.43	4.56	3.44	0.30	0.79
Fleischmann	85.5			4.8	4.0	3.8	1.2	0.7
Pizzi	86.75			5.35	3.60		3.64	0.67
Richmond	86.76			3.78	4.49		4.10	0.87
Piccardi	82.46			6.10	3.95	5.56	1.01	0.93
Stienegger	88.40			3.25	4.80		3.92	0.63
Bosworth				3.80	4.5		3.1	
Winton and Winton (20) quote:								
Pallatases:								
Mountain		15.22		6.11	4.12		4.20	0.80
Maltese		13.79		4.91	4.27		3.80	0.81
Stohman et al.:								
Min.		11.67		2.29	4.37		3.44	0.83
Max.		16.80		7.14	5.13		4.90	1.00
Hogan and Azadian:								
Min.		10.65		2.45				
Max.		16.55		7.35				
Average		12.54		4.04				
Associates of Rogers (1) quote.								
Frahm	87.14			4.09	4.20		3.71	0.78
Cunningham (3) quotes.								
Renesse	85.50			4.80	4.00		5.00	0.70
Landweinth	85.60			4.60	4.30		4.80	
Hoffman	86.19			4.73	4.50		3.68	0.90
Koenig	86.88			4.07*	4.64		3.76	0.85
Espe et al. (7)				4.09	4.28		3.71	0.78
Jordan and Smith (9)		12.12	8.30	3.82		2.40	3.21	0.55
Bosworth and Van Slyke (2)		12.34		3.80	4.50		3.10	0.94
Davies (5)								
(a)	82.34			7.57	4.96	3.62	0.60**	
(b)				4.33	3.61	2.91	0.76**	
Voorhies (19)	86.09	13.81		4.79	4.85		3.55	0.72
Gamble et al. (8)								
Average***	88.29			3.5	4.55		3.10	0.79
Lythgoe (12)								
Average ind. goats:								
77 samples Dec. 21-Jan. 26		14.50	9.42	5.08	4.78		3.99	0.85
62 samples Feb. 1-Feb. 28		14.56	9.43	5.13	4.87	2.98	3.97	0.85
35 samples Mar. 1-Mar. 9		14.08	9.28	4.80	5.03	2.74	3.74	0.76
49 samples May 23-July 6		12.24	8.45	3.79	4.66		3.34	0.77
87 samples Aug. 1-Aug. 31		11.47	8.10	3.37	4.32		2.99	0.78
25 samples Sept. 20-Sept. 26		12.29	8.31	3.98	4.49		3.16	0.79

*Variations, 2.29-7.55 per cent (compiled from about 100 analyses).

**Protein other than casein.

***Mixed milk Saanen and Toggenberg combined 1929-32.

the year 1912 was as follows: Solids, 11.4% to 11.9%, S.N.F. 7.72% to 8.61%, fat 3.5% to 3.84%. The composition of milk from individual goats was found to vary in T. S. from 9.22% to 18.55%; in protein from 2.24% to 4.96%; in casein from 1.56% to 4.6%; in fat from 1.08% to 8.4%; and in ash from 43% to .8%."

Lythgoe (12) concluded from analyses of goats' milk of known purity from 335 individual goats and from 21 herds, that the variation in the total solids and fat was greater than is the case with cows' milk. The composition of goats' milk varied seasonally also, being much less in solids during the summer than in the winter months. The variation of composition of goats' milk according to the month of the year is shown in Table 3.

Table 3. Analysis of goats' milk by months.

	Total solids per cent	Fat per cent	Solids-not-fat per cent	Lactose per cent	Proteins per cent	Ash per cent	Protein-fat ratio per cent
HERD MILK							
Gamble et al (8)							
February	13 05	4 30	8 75	4 91	3 39	0 82	0 79
March	12 45	4 10	8 35	4 46	3 34	0 79	0 79
April	11 82	3 70	8 12	4 68	2 98	0 76	0 80
May	11 49	3 50	7 90	4 62	2 87	0 76	0 82
June	11 19	3 50	7 69	4 34	2 88	0 77	0 82
July	11 06	3 30	7 76	4 49	2 79	0 75	0 84
August	10 78	3 10	7 68	4 40	2 77	0 77	0 89
September	10 80	3 10	7 70	4 44	2 87	0 77	0 92
October	11 85	3 50	8 35	4 50	3 22	0 80	0 92
November	11 91	3 20	8 71	4 38	3 61	0 85	1 13
December	12 36	3 50	8 86	4 75	3 53	0 85	1 00
Average	11 71	3 50	8 21	4 55	3 10	0 79	0 89
INDIVIDUAL GOAT'S MILK							
Lythgoe (12)							
December and January	14 50	5 08	9 42	4 78	3 99	0 84	0 78
February	14 56	5 13	9 43	4 87	3 97	0 85	0 78
March	14 08	4 80	9 28	5 03	3 74	0 76	0 80
May, June and July	12 24	3 79	8 45	4 66	3 34	0 77	0 86
August	11 44	3 37	8 07	4 32	2 99	0 78	0 89
September	12 29	3 98	8 31	4 49	3 16	0 79	0 82

The analyses of 40 samples of Michigan goats' milk for fat and total solids are presented in Table 4. The percentage of fat was determined by the Babcock method, that of total solids by the Mojonnier method and that of the solids-not-fat was calculated from the values obtained for fat and for total solids. The samples represented mixed milk, from large and from small herds and milk from individual animals. The average analysis appeared to compare favorably with those reported in the literature.

So far as possible the data of Table 4 were regrouped and studied according to the breeds represented. The results are presented in Table 5. The average fat test was found to be highest in Nubian milk, slightly less in Saanen milk, followed by milk from mixed breeds and

Table 4. The fat, solids-not-fat, and total solids of goats' milk submitted by Michigan producers during 1940.

Sample No	Fat	Solids-not-fat	Total solids
	per cent	per cent	per cent
1	2.8	8.71	11.51
2	3.3	9.55	12.85
3	4.9	8.85	13.75
4	4.9	8.75	13.65
5	3.5	8.49	11.99
6	4.1	9.46	13.56
7	4.9	9.27	14.17
8	3.7	8.59	12.29
9	3.2	7.81	11.01
10	4.0	8.26	12.26
11	4.0	9.02	13.02
12	3.2	8.24	11.44
13	4.2	(Lost)	(Lost)
14	5.1	8.95	14.05
15	4.0	8.85	12.85
16	3.4	9.80	13.20
17	3.3	8.49	11.79
18	3.8	8.64	12.44
19	3.9	9.31	13.21
20	4.9	9.64	14.54
21	4.7	9.54	14.24
22	3.3	(Lost)	(Lost)
23	2.8	(Lost)	(Lost)
24	2.8	8.26	11.06
25	2.7	8.29	10.99
26	2.85	9.02	11.87
27	2.7	9.04	11.74
28	2.9	9.14	12.04
29	4.6	9.28	13.88
30	4.35	9.45	13.80
31	4.3	9.11	13.41
32	4.1	9.48	13.58
33	4.35	9.26	13.61
34	4.5	9.24	13.74
35	4.5	9.26	13.76
36	4.6	8.99	13.59
37	4.25	9.66	13.91
38	4.3	9.72	14.02
39	4.5	9.86	14.36
40	4.4	9.59	13.99
<hr/>			
Average	3.91 ± 0.75	9.05 ± 0.496	13.00 ± 1.04
<hr/>			
Range	3.7 — 5.1	7.81 — 9.86	10.99 — 14.54

least in the Toggenberg milk with an average of 3.54 per cent. However, the fat percentage of the milk within the breeds varied widely.

The graphic relationship between the percentage fat and percentage solids-not-fat is shown in Fig. 1.

Ash

The ash content of goats' milk as reported by several investigators is included in tables 2 and 3. Here it will be noted a range from a low of 0.55 per cent to a high of 1.09 per cent, the majority of those reported being in the proximity of 0.80 per cent. Kelly and Clement (10) found on compiling the results of analysis of cows' milk by seven American and one English investigator, that the average ash content was 0.72 per cent.

Lythgoe (12) found that 50 per cent of 150 samples of goats' milk collected between December and March had an acetic serum ash con-

Table 5. The analysis of goats' milk submitted by Michigan producers during 1940, according to breed.

Sample No	Fat per cent	Solids- not-fat per cent	Total solids per cent	Acidity per cent	Ash per cent
TOGGENBERG					
6	4.1	9.46	13.56	0.16	Not determined
7	4.9	9.27	14.17	0.17	" "
8	3.7	8.59	12.29	0.13	" "
10	4.0	8.26	12.26	0.12	" "
12	3.2	8.24	11.44	Lost	" "
14	5.1	8.95	14.05	0.16	" "
24	2.8	8.26	11.06	0.225	0.872
25	2.7	8.29	10.99	0.225	0.894
26	2.85	9.02	11.87	0.205	0.913
27	2.7	9.04	11.74	0.205	0.930
28	2.9	9.14	12.04	0.205	0.884
Average	3.54	8.77	12.31	0.180	0.898
Standard deviation	±0.84	±0.43	±1.06	±0.036	±0.046
NUBIAN					
29	4.6	9.28	13.88	0.255	0.919
30	4.35	9.45	13.80	0.26	0.923
31	4.30	9.11	13.41	0.251	0.930
32	4.10	9.48	13.58	0.260	0.972
33	4.35	9.26	13.61	0.240	0.955
34	4.50	9.24	13.74	0.230	0.938
35	4.50	9.26	13.76	0.240	0.936
36	4.60	8.99	13.59	0.230	0.948
Average	4.41	9.25	13.67	0.245	0.940
Standard deviation	±0.159	±0.15	±0.14	±0.012	±0.012
SAANAN					
15	4.00	8.85	12.85	0.15	Not determined
16	3.40	9.80	13.20	0.13	" "
19	3.90	9.31	13.21	0.18	" "
20	4.90	9.64	14.54	0.23	" "
21	4.70	9.54	14.24	0.22	" "
Average	4.18	9.42	13.60	0.18	—
Standard deviation	±0.549	±0.329	±0.658	±0.043	—
MIXED BREEDS					
1	2.8	8.71	11.51	0.22	Not determined
2	3.3	9.55	12.85	0.185	" "
3	4.9	8.85	13.75	0.16	" "
4	4.9	8.75	13.65	0.15	" "
5	3.5	8.49	11.99	0.15	" "
9	3.2	7.81	11.01	0.145	" "
11	4.0	9.02	13.02	0.21	" "
13	4.2	Lost	Lost	0.155	" "
17	3.3	8.49	11.79	0.13	" "
18	3.8	8.64	12.44	0.14	" "
22	3.3	Lost	Lost	0.175	" "
28	2.8	Lost	Lost	0.170	" "
37	4.25	9.66	13.91	0.270	.925
38	4.30	9.72	14.02	0.275	.930
39	4.50	9.86	14.36	0.27	.915
40	4.4	9.59	13.99	0.275	.911
Average	3.84	9.01	12.94	0.192	0.920
Standard deviation	±0.065	±0.59	±1.06	±0.049	±0.007

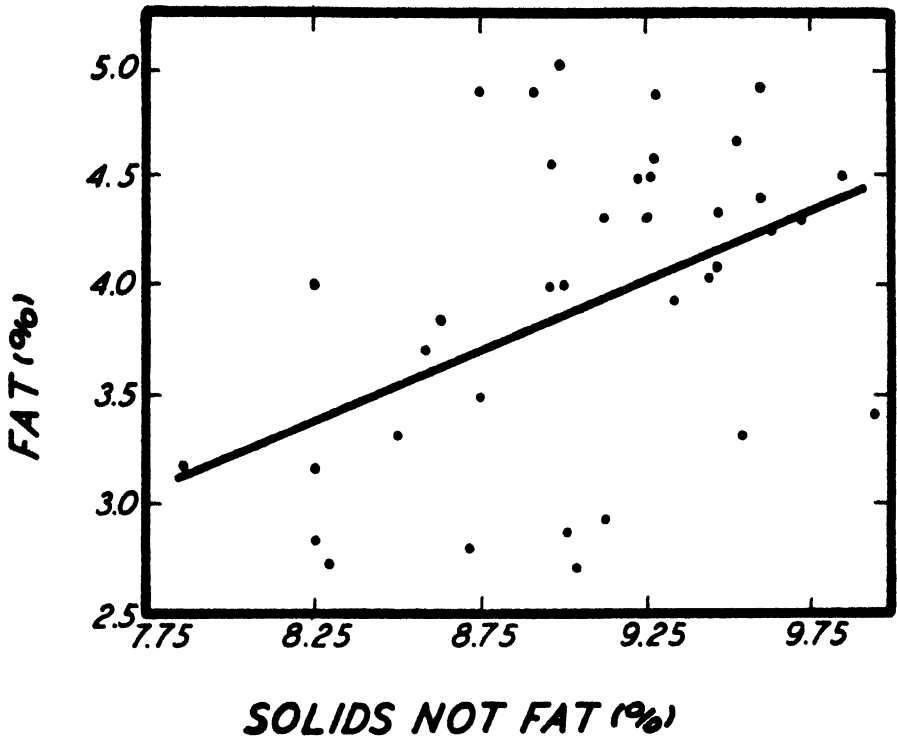


Fig 1 Regression curve of percentage fat on percentage of solids-not-fat.

tent between 0.822 and 0.910 per cent, and that 50 per cent of 120 samples collected between May and September had an ash content between 0.793 and 0.878 per cent. These figures were slightly higher than those found on 371 samples of cows' milk, of which 50 per cent had a sour serum ash content between 0.759 and 0.804 per cent. From these figures it would appear that the ash content of goats' milk is slightly higher than that of cows' milk.

The samples analyzed in this study would tend to substantiate previous findings in this respect. The ash content of 17 samples of individual and mixed herd goats' milk determined by the Section of Chemistry of the Michigan Agricultural Experiment Station and presented in Table 5 showed an average of 0.923 per cent with a range from 0.872 to 0.972 per cent. The ash content of breed milk varied slightly with the fat as shown in Table 4.

Specific Gravity

Jordan and Smith (9) found the average specific gravity of goats' milk to be 1.0294, a figure somewhat lower than that reported by Voorhies (19) which averaged 1.034 and ranged from 1.0310 to 1.0370.

Specific gravity determinations made on 17 samples of goats' milk in these studies, presented in Table 5, showed an average of 1.0337 with a range from 1.032 to 1.035.

Acidity or Alkalinity of Goats' Milk

The opinion seems to be current among some goat milk producers that goats' milk has an alkaline reaction while cows' milk has an acid reaction. In fact, Richards (14) states, "Other differences between goat milk and cow milk are: the fact that goat milk is alkaline in its reaction while cow milk is acid, a matter of the greatest importance to persons suffering from hyperacidity of the stomach, . . ."

Data available on the reaction of fresh goats' milk indicate that goats' milk is acid in reaction and not alkaline. Turner, Ragsdale and Garrison (18) reported the average titratable acidity, calculated as lactic acid, of several samples of fresh goats' milk of 0.15 per cent with a range from 0.10 to 0.17 per cent.

The results obtained upon titrating 39 samples of fresh goats' milk, presented in Table 6, showed a range in titratable acidity from 0.12 to 0.275 per cent with an average of 0.199 per cent. All the samples were brought to the laboratory packed in ice, were below 50° F., and had no

Table 6. The titratable acidity, pH, ash, and specific gravity of samples of goats' milk submitted by Michigan producers during 1940.

Sample No.	Titratable acidity	pH	Ash	Specific gravity
	per cent		per cent	
1..	0.220	Not measured	Not determined	Not determined
2..	0.185	" "	" "	" "
3..	0.160	" "	" "	" "
4..	0.150	" "	" "	" "
5..	0.150	" "	" "	" "
6..	0.160	" "	" "	" "
7..	0.170	" "	" "	" "
8..	0.130	" "	" "	" "
9..	0.145	" "	" "	" "
10..	0.120	" "	" "	" "
11..	0.210	" "	" "	" "
12..	Lost	" "	" "	" "
13..	0.155	" "	" "	" "
14..	0.160	" "	" "	" "
15..	0.150	" "	" "	" "
16..	0.130	" "	" "	" "
17..	0.130	" "	" "	" "
18..	0.140	" "	" "	" "
19..	0.180	" "	" "	" "
20..	0.230	6.49	" "	" "
21..	0.220	6.47	" "	" "
22..	0.175	Not measured	" "	" "
23..	0.170	" "	" "	" "
24..	0.225	6.33	0.872	1.032
25..	0.225	6.43	0.894	1.032
26..	0.205	6.42	0.913	1.032
27..	0.205	6.52	0.930	1.033
28..	0.205	6.43	0.884	1.032
29..	0.255	6.37	0.919	1.035
30..	0.260	6.35	0.923	1.035
31..	0.251	6.40	0.930	1.034
32..	0.260	6.40	0.972	1.034
33..	0.240	6.42	0.955	1.034
34..	0.230	6.43	0.938	1.033
35..	0.240	6.43	0.936	1.033
36..	0.230	6.43	0.948	1.034
37..	0.270	6.40	0.925	1.035
38..	0.275	6.35	0.930	1.035
39..	0.270	6.40	0.915	1.035
40..	0.275	6.40	0.911	1.035
Average.....	0.199 ±0.046		0.923 ±0.024	1.0337 ±0.0014

detectable odor indicating bacterial growth. In fact the bacterial counts were found, in general, to be extremely low. These results are slightly higher than those generally encountered in titrating normal fresh cows' milk.

The reaction of goats' milk as shown by the hydrogen-ion concentration is slightly more acid than cows' milk.

Schultz and Chandler (16) found goats' milk to range in pH from 6.4 to 6.7, which is slightly lower than the average attributed to cows' milk, 6.6 (1) and to the range from 6.4 to 6.8 (17).

Schultz and Chandler (16) stated: "The results obtained from 160 determinations on fresh goat's milk varied from pH 6.7 to 6.4. The average pH for 86 morning samples was 6.52; for 74 evening samples 6.54; and 6.53 for the total number. The end points of 73 samples of soured goat's milk varied from pH 4.4 to 3.7, averaging 3.92." They concluded: "The average hydrogen-ion concentration of fresh goat's milk is 6.53; that of completely soured milk 3.92. Fresh goat's milk is therefore slightly more acid than fresh cow's milk, and appreciably more acid than human breast milk. Soured goat's milk is considerably more acid than soured cow's milk."

Gamble, Ellis and Besley (8) found the initial hydrogen-ion concentration on four samples of goats' milk to range from pH 6.54 to 6.57; on two samples of Jersey milk from 6.62 to 6.66 and on one sample of Holstein milk 6.70, thus indicating that goats' milk was slightly more acid than cows' milk.

Measurements taken on 19 samples of fresh goats' milk, presented in Table 6 showed a range in pH from 6.33 to 6.52, somewhat lower than that reported by Gamble and co-workers (8) but in line also with their findings that the pH of fresh goats' milk was slightly lower than that normally attributed to cows' milk. Seventeen of these samples were from one herd representing the Toggenberg and Nubian breeds and were both of individual and of mixed samples.

Flavor of Goats' Milk

Much adverse criticism without adequate foundation seems to have been made of the flavor of goats' milk, presumably because of the offensive odor associated with the buck during breeding season. The allusion to "goaty" flavored goats' milk by many people seems to be based upon fiction rather than fact. Doubtless several factors affect the flavor of goats' milk much the same as they affect the flavor of cows' milk. However, it must be recognized that production of goat milk from a healthy goat in normal production under proper feed and herd management and sanitation results in a milk which merits no severe flavor criticism. Goats' milk apparently is as capable of possessing a clean wholesome flavor as cows' milk. On the other hand, it seems to have a distinct, characteristic flavor of its own somewhat different from that of cows' milk. Matthews and Weaver (13) stated "Goat's milk produced under sanitary conditions does not have an unpleasant 'goaty' flavor and odor although it does have a flavor different from that of cow's milk."

The report of the Sixth Annual National Goat Milk Scoring Contest (4) shows that 90 samples of goats' milk ranged in score from 25 (a perfect score for flavor) to 18. Forty-eight, or 50.3 per cent, of the

samples were scored 23.0 or higher, a score usually given for a flavor above criticism.

The flavor and score of the samples of goats' milk examined during the past year are included in Table 7. The average flavor score was found to be 21.75, which is in the class of milk recognized as having good flavor. It must not be overlooked, however, that 19 samples, or 47.5 per cent scored 23 or higher, having no flavor criticism. Of the off-flavors present, those of "feed" were noted in 10 samples. Likely these feed flavors could be overcome by proper feeding management rather than a change in the feed. The cow milk producer and distributor fully appreciate the importance of feeding flavor-producing feeds after milking. The goat milk producer should follow the same procedure.

Much has been written on the absorption of odors by milk, particularly cows' milk. Yet, actual research data are rather limited.

One study on absorption of odors by goats' milk, that of Dom-browsky (6) is of interest. He placed goats' milk in saturated atmos-

Table 7. The flavor score and criticism of goats' milk submitted by Michigan producers during 1940.

Sample No.	Flavor		Bottle and cap		Sediment score
	Score	Criticism	Score	Criticism	
1	22	Sl. flat	4.75	Not sealed	9 0
2	21.5	Sl. feed	5.00		7.5
3	21.0	Sl. off, feed	5.00		9 0
4	21.0	Sl. off, feed	5.00		9 0
5	21.5	Sl. feed	4.75	Not sealed	8 0
6	21.5	Feed	5.00		—
7	23.0	Excellent	3.75	Not protected, not sealed	—
8	21.5	Sl. feed	5.00		—
9	19.0	Salty, unclean	3.75	Not protected, not sealed	7.5
10	20.0	Feed, sl unclean	5.00		8 0
11	20.5	Sl. metallic	4.75	Not sealed	9 0
12	20.5	Sl. metallic	4.75	Not sealed	9 5
13	18.0	Off, peculiar, unclean	4.75	Not sealed	8 0
14	21.0	Feed	3.75	Not protected, not sealed	5 0
15	20.5	Sl. salty, alkaline	5.00		9 0
16	23.5	Excellent	3.75	Not protected, not sealed	9 25
17	20.0	Alkaline	4.75	Not sealed	8.00
18	19.0	Alkaline	4.75	Not sealed	—
19	21.0	Sl. feed	4.75	Not sealed	6.00
20	23.0	Excellent	Not observed		Not observed
21	23.0	Excellent	"	"	" "
22	23.0	Excellent	"	"	" "
23	22.0	Sl. salty, sl feed	"	"	" "
24	20.0	Salty	"	"	" "
25	21.0	Sl. salty	"	"	" "
26	23.0	Excellent	"	"	" "
27	23.0	Excellent	"	"	" "
28	23.0	Excellent	"	"	" "
29	23.0	Excellent	"	"	" "
30	23.0	Excellent	"	"	" "
31	23.0	Excellent	"	"	" "
32	23.0	Excellent	"	"	" "
33	23.0	Excellent	"	"	" "
34	23.0	Excellent	"	"	" "
35	23.0	Excellent	"	"	" "
36	23.0	Flat	"	"	" "
37	23.0	Excellent	"	"	" "
38	23.0	Excellent	"	"	" "
39	23.0	Excellent	"	"	" "
40	23.0	Excellent	"	"	" "
Average	21.75 = 1.42				

pheres of iodoform, phenol, oil of anise, oil of turpentine, formalin and chloride of lime and noted the relative absorption of the odors. In general he found that: (a) The milk took on rapidly the odor of iodoform and of anise and held those odors for a long time, 12 hours; (b) the milk rapidly absorbed the odor of carbolic acid, but lost it easily; (c) the milk took on rapidly the odor of turpentine and of formalin and gave them off readily also; and (d) the milk took on very faintly the odor of chloride of lime.

Not only were the substances used by Dombrowsky very odoriferous, but the milk was placed in a saturated atmosphere of them, conditions very unlikely to be encountered in actual goat milk production. While it is highly advisable to remove the milk from the stable immediately after milking and cooling promptly, flavors attributed to absorption of surrounding odors are very likely the result of the animal breathing the odor-laden air and thus imparting the odor to the milk. Rather than emphasizing the possibility of direct absorption of odors in producing good flavored goat milk, more consideration should be given to proper ventilation of the stable; to wide separation of the buck from the milking herd; to general stable cleanliness; and to freedom from odors, so that the doe herself may not be forced to breathe the foul, unpleasant, or off odors, thus imparting them to the milk.

The data included in this paper are presented chiefly that more information on goats' milk might be available not only to goat milk producers, but to those interested in goat milk as well.

Credit is due Dr. W. D. Baten, Section of Mathematics, Michigan Agricultural Experiment Station, for guidance in the statistical treatment of some of the data.

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STAGHEADED PASTURE TREES

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Farmers who have had trees in their pasture or woodland pasture slowly die from the top down may have desired to discover the cause. Such single trees in pastured fields often lose their leaves at the top and become what is commonly called "stagheaded". This condition is characterized by numerous dead branches in the upper part of the crown and the ends of the side branches. Generally the branches continue to die back slowly until the entire tree is dead.

Trees are often left in pastures for their aesthetic value or with the intention and hope that they will supply shade for the animals pastured there. In most cases it is these same animals—horses, cattle, or sheep—which cause the slow death of these trees. The animals stand in the shade under the trees during the heat of the day and continually stamp and paw the ground in their endeavor to shake flies from their legs. Their sharp hoofs cut and injure the surface roots and compact the ground until it becomes hard and dry. The loss of roots and the hardened soil reduce the ability of the tree to get sufficient moisture and nutrients. This causes the branches farthest from the roots to die, and the tree becomes 'stagheaded'.

Fig. 1 shows a low-spreading red oak (*Quercus borealis*) which was killed by the horses and cattle which used the tree for shade. The broken and barked roots and the hard bare ground around the tree are clearly discernable. Even though the photograph was taken one year after the death of the tree



Fig 1 Red oak killed by horses and cattle injuring the roots



Fig 2 Stagheaded red oak providing shade for cattle

and after the animals no longer used the tree for shade, still the soil is so compact that grasses have not yet grown or seeded into the trampled area.

Fig. 2 shows a red oak which is approximately 200 feet from the dead red oak shown in Fig. 1. This tree still provides shade, and all the cattle and horses in the pasture congregated around it during the summer the photograph was taken. It was also suffering from loss of moisture and root injury and had become stagheaded as is clearly shown in the photograph. This tree probably would have died in a few years if it had not been protected from further injury.



Fig. 3. Red oak recovering from stagheadedness.

To protect this oak all the dead branches were removed and the lower branches were pruned and thinned so that the sunlight passed through them and broke up the solid shade. The horses were no longer pastured in this field, and shade was provided for the cattle from the north side of a building adjacent to the pasture fence.

Fig. 3 shows the red oak in Fig. 2 four years after it received the treatment described. Pasture trees that have become "stagheaded" may be saved by pruning the tree of all dead limbs and thinning out the lower branches and mulching around the tree inside the branch drip area with 2 or 3 inches of coarse gravel or crushed stone. When it is not essential that the cattle have the tree shade, the tree should be guarded by a protecting fence 6 to 8 feet from the tree trunk.

IMPROVEMENT IN THE CHATHAM DAIRY HERD

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An increase in production of 3,159 pounds of milk and 171.2 pounds of fat per cow has been obtained in the purebred Holstein herd at the Chatham sub-station of Michigan State College during the past 15 years. This increase has been due to improvements in three factors: breeding, selection, and feeding and management. It is impossible to isolate the influence of each. Attention is being called to the effort of building up the herd through breeding. Table 1 gives the average records of the herd.

Table 1. Number of cow years and average yields by years.

	Cow years	Average milk	Test	Average fat
		(pounds)	(per cent)	(pounds)
1924-25.....	12.6	10,635	2.85	303.6
1925-26.....	17.4	11,256	3.0	347.9
1926-27.....	18.5	11,750	2.86	335.9
1927-28.....	18.2	11,778	3.14	369.6
1928-29.....	20.0	9,084	3.25	295.6
1929-30.....	19.6	11,657	3.01	351.4
1930-31.....	10.1	12,037	3.03	364.3
1931-32.....	21.2	11,691	2.91	348.2
1932-33.....	21.0	12,072	3.08	356.7
1933-34.....	16.3	13,614	3.14	428.3
1934-35.....	14.2	13,622	3.28	449.5
1935-36.....	16.1	13,874	3.25	451.1
1936-37.....	15.5	12,128	3.28	399.1
1937-38.....	17.0	11,699	3.48	407.0
1938-39.....	16.6	12,942	3.48	451.9
1939-40.....	15.0	13,794	3.44	474.8
1940-41.....	17.3	9,895	3.58	354.0 (9 mo.)

The first record was made when the Marquette-Alger Dairy Herd Improvement Association was started in 1924. Testing has continued ever since. In 1928 the Herd Improvement Registry of the Holstein-Friesian Association was inaugurated. The Chatham herd was immediately placed on that test and has continued H. I. R. testing along with D. H. I. A. work. For this study, however, only D. H. I. A. records are used for they continue throughout the entire 15 years. Every cow that freshened is on test. If a cow is dry for several months, she is counted in the herd average. Until a cow actually goes out of the herd for some reason, she is kept on test. Records of the Herd Improvement Registry are usually higher than those given above.

Early History

The Chatham herd was established in 1912, when six purebred Holstein females were purchased in Livingston County. Since these original cows were brought to Chatham, no females have been introduced into the herd.

The herd from which this foundation stock was purchased had been improved through records of milk production. Testing of milk was not carried on with any regularity. That is no doubt the reason the percentage of butterfat in the Chatham herd was found to be at the low point of 2.85 the first year of herd testing. This character turned out to be rather persistent since even with bulls selected from high-testing cows, it was possible to raise the test only about two-tenths of one per cent in eight years. Since 1933, the test has been increased to 3.58, which can be considered a major accomplishment in the improvement of the herd.

Herd Bulls

Table 2 gives the average production of cows in the herd classified as to sires.

All cows that have been milked are shown in Table 2 regardless of the length of time in the herd. A cow year is 1/12 of the total number of months the cows are in the herd after freshening--milking or dry.

Table 2. The bulls whose daughters have comprised the herd, with the average yield of each bull's daughters.

Bull	No. different cows	Cow years	Average milk	Test	Average fat
			(pounds)	(per cent)	(pounds)
Segis Houwtje Cornucopia King 68670	1	7 0	8319	3 07	255 7
College Fobes DeKol 111266	2	10 8	11049	3 11	343 9
Emblagaard Colantha Ladoga 182103	5	16 8	11625	2 78	318 3
Emblagaard Colantha Banostine 263137	7	27 0	11315	2 99	338 0
Canary Segis Beets 237625	14	14 5	11811	3 11	367 3
Chatham Segis DeKol 449591	1	3 3	9902	3 34	330 7
Chatham DeKol Longfield 430505	1	1 4	9160	2 86	262 7
Traverse Echo Prince Segis 465512	17	57 0	12311	3 03	373 1
Traverse Colantha Sylvia Marathon 548515	9	17 6	11767	3 18	374 0
Fobes Pietertje Ormsby 341217	19	54 2	13335	3 31	441 5
U Neb Topsy Quantor 650203	14	36 4	12833	3 46	444 6
Pabst Crusader Pontiac Duke 618734	15	11 3	12282	3 66	450 2

Segis Houwtje Cornucopia King was never in the herd, but his daughter, Beauty Pietertje Segis DeKol 211959, made a profound impression on the herd. Daughters of the first four bulls were in the herd the first year of testing. Daughters of Canary Segis Beets started coming into production in 1925-26 and had some effect in raising the fat percentage two years later. Neither Chatham Segis DeKol nor Chatham DeKol Longfield have had any appreciable effect on the herd since each left but one daughter.

As soon as the first testing year was completed and it was seen that the herd test was below 3.0 per cent, an effort was made to correct that situation by sire selection. Traverse Echo Prince Segis was selected as a young bull because of the high percentage of fat carried by his dam. Her record was made on a seven-day test. Records show that while average milk and fat production of his daughters was higher than in the daughters of any previous bulls, the test was lower than the daughters of Canary Segis Beets. One result of using Traverse Echo Prince Segis is that the udders of his daughters were closely attached to the bodies. This was a great change from the pendulous type of udders of their dams that were frequently injured, resulting in a serious mastitis problem. It is believed that this change in type of udder was a big factor in eliminating mastitis from the herd later.

In 1930 a proved sire, Fobes Pietertje Ormsby, was brought into the herd. When his daughters started coming into production during the fall of 1933, it was necessary to reduce the size of the herd from 21 to 16 cows. This close culling, along with the good production of daughters of Fobes Pietertje Ormsby, caused the herd to produce more than 400 pounds of fat for the first time. Daughters of the same bull were largely responsible for the high herd average the two succeeding years. In Table 2 the average of all daughters of this bull is seen to be the highest in production as well as the highest in test of any sire used in the herd to that date except for one bull with only one daughter.

In 1936-37 the lowest production since 1933 was obtained, partially due to decreasing milking to twice daily. Milking three times daily had been practiced from 1924 until September 1936. During 1936-37, also, 10 daughters of U Neb Topsy Quantor were in production, and it was found that these daughters as a rule matured slowly, taking two, three, and even four lactations to reach their best production. Daughters of Quantor were largely responsible for the high records of 1938-39 and 1939-40. Even though milked twice daily, these daughters showed a higher butterfat yield than those of Fobes Pietertje Ormsby—simply because of the higher test.

The bull following "Quantor" was Pabst Crusader Pontiac Duke, bred by Pabst Farm. This bull was obtained from Fisher Bros. herd near Crystal Falls, Mich., where he had been proved good. Table 2 shows the daughters of "Duke" producing at a higher level than any previous bull. Actually only six daughters have completed the first lactation so the records given are not a true indication except in the case of the per cent fat. Daughters of "Duke" are testing higher than the dams in each case.

On Jan. 1, 1941, 11 of the 17 milking cows were daughters of "Duke". Three daughters of Fobes Pietertje Ormsby and three of "Quantor" composed the rest of the herd.

PUREBREDS vs. CROSS-BREDS AS CAPONS AND ROASTERS

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(A PROGRESS REPORT)

Introduction

Poultry producers in recent years have raised the question of whether the performance of progeny from "pure" breeds is superior to that from so-called "hybrids" or "cross-breeds". In seeking the answer to such a question much depends upon the measures of performance and a definition of the words "pure" and "cross-bred". As a general rule the characteristics which determine acceptance in a breed classification are not necessarily identical with characteristics of performance. In other words, fowls may be related according to breed characteristics but unrelated with respect to performance.

Perhaps part of an ideal program for comparing pure breeds with cross

*The assistance of Mr. Ray Pillar is gratefully acknowledged

breeds is to develop strains or families whose performance is relatively uniform but this process involves inbreeding as well as considerable time. An indirect answer to a related question may be obtained by a procedure more in keeping with current practice, that is to compare the purebred with the cross-bred progeny of several unrelated families. The development of uniform strains is proceeding but more time will be required. Meanwhile, the results of the work to date are presented as a matter of information.

This is a preliminary and partial report of a project designed to determine what differences in market quality exist between the progeny of purebred and cross-bred chickens when grown to roasting age.

The breeds chosen were Barred Plymouth Rock, Rhode Island Red, White Leghorn and crosses of White Cornish males with Barred Rock females and Dark Cornish males with White Leghorn females. The chicks were hatched June 13, 1940, in the same incubator. They were reared on identical rations in battery brooders for the first six weeks after which they were transferred to outdoor pens. They were weighed individually at hatching time and at each four-week period thereafter.

The average weights of the male progeny (capons and cockerels) at 12, 24 and 36 weeks are shown in Table 1.

Table 1. Average weights* of capon and cockerel progeny of five matings at 12, 24 and 36 weeks.

Breed and sex	Weight and age in weeks		
	12	24	36
Barred Rock	2 7	5 4	7 0
**Capon	2 8	5 8	7 1
Cockerels	2 6	5 0	6 8
Rhode Island Red	2 4	5 4	6 7
**Capon	2 4	5 2	6 6
Cockerels	2 3	5 5	6 9
White Leghorns	2 2	3 8	4 4
**Capon	2 3	3 7	4 7
Cockerels	2 1	3 8	4 3
W. Cornish x B. Rocks	2 7	5 7	7 5
**Capon	2 7	5 6	7 8
Cockerels	2 6	5 8	7 4
D. Cornish x W. Leghorns	2 7	5 2	6 3
**Capon	2 6	5 05	6 5
Cockerels	2 8	5 23	6 2

*Weights to the nearest one tenth pound

**Caponized at the 8th week

The breeding of the birds from which the weights (Table 1) are compiled was as follows: The purebred birds were from flocks of approximately 200 females mated at random to 10 males. Each bird had a different dam but they may have had the same sire. The cross-breeds were from two pens of approximately 12 females each mated to a single male.

Results

In early growth the birds from the heavy strains have a slight advantage over the Leghorns and Reds, but the cross-breeds average weight is identical with that of the Barred Rocks (2.7 lb.). At the 24th week the White Cornish x Barred Rock cross-breeds have a slight advantage which they retain until the 36th week.

No attempt was made to "fatten" the capons and their weights are comparable to those of the cockerels in nearly every case. The differences which are apparent probably are not beyond the range of experimental error.

Market Grades

The birds were prepared for market at 36 weeks and the number of birds in five different grades is indicated in Table 2.

It will be noted that the cockerels were retained beyond the age common in current practice. The reason for retaining the cockerels beyond the normal market age was to compare them with the capons in market grade, cooking and tenderness tests.

Table 2. Distribution of market carcass grades by breeds at nine months of age.

Breeds	Grades				
	AA	A	B	C	C —
Barred Rocks	1	4	4	1	
Capon	1	2	2		
Cockerel		2	2	1	
Rhode Island Reds		6	3	1	
Capon		2	3		
Cockerel		4		1	
White Leghorns			2	6	
Capon				3	
Cockerel			2	3	
W. Cornish x B. Rocks	6	3	1		
Capon	3	1	1		
Cockerel	3	2			
D. Cornish x Leghorn	5	5			
Capon	2	3			
Cockerel	3	2			

From Table 2 it is apparent that the Cornish top crosses are superior in market appearance in the opinion of 3 to 5 judges. The "broad-breast" type of the Cornish seems dominant to the Leghorn type at least, for none of the Leghorns graded above B whereas, with one exception, the Cornish top crosses graded A or better.

The favorable carcass grades obtained with the Cornish top cross suggests that Cornish males might be used in the Leghorn flocks outside of the regular breeding season to produce frying or roasting chickens. The Cornish males have pea combs which are dominant so that any chicks from Cornish males would be distinctly marked. The chicks would be white, mostly, but a few buff or pale red feathers would occur occasionally.

AN INTERMITTENT DISCHARGE VALVE FOR THE SEPTIC TANK

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SECTION OF AGRICULTURAL ENGINEERING

The septic tank and tile system is recognized as the safest practical method of disposing of sewage and household wastes for country installation. The system consists essentially of:

1. House sewer,
2. The septic tank, consisting of one or more chambers,
3. The distributing system, and
4. The filter bed or final disposal field.

House Sewer—This may be of any length but usually connects with the septic tank at a short distance from the house to avoid sewer and freezing troubles.

Septic Tank—The septic tank designed for breaking down sewage and reducing it to a liquid through the action of anaerobic (absence of air) bacteria. It is designed so that inlet, direction and rate of flow, outlet and other details favor bacterial action through:

1. Little disturbance of the liquid,
2. Progressive passage of liquid through the tank,
3. Providing for scum accumulation at the top,
4. Providing for sludge accumulation at the bottom, and
5. Introduction and removal of liquid.

The siphon or valve chamber is sometimes added to the anaerobic chamber where it is desired to accumulate the liquid from the first chamber in sufficient volume to fill the disposal tile lines and secure more effective distribution and aeration.

The Tile Field—From the first or sedimentation chamber the liquid is sometimes discharged into the disposal tile system as fast as the tank receives it. It is considered better design to hold the liquid in a second chamber and discharge it periodically. In either case the effluent from the tank is carried a safe distance (not less than 50 feet) from the well through pipe laid with sealed joints. It may then be distributed by one foot long drain tile with joints separated about $\frac{1}{8}$ ". These tile should be laid in a trench about 24 inches deep, in which is placed 6" of gravel to assist aeration. The disposal tile may be laid virtually level and should be kept so, even on irregular ground, by following the contour of the ground.

The Intermittent Discharge Valve—In extension work on sewage disposal a septic tank design has been used without material change for more than 20 years. In reviewing the design it seemed desirable

to increase the size to meet the increased use of water and to improve it where possible to simplify the installation. The septic tank is so essential to the complete utilization of water that the convenience and safety it offers should be available to all.

Sewage is discharged into the tile lines to complete the reduction processes by soil bacteria. To favor action on the tank effluent by soil bacteria, the liquid should be spread over a definite area of soil through the lines. Intermittent discharge of the contents of the holding or second chamber of the septic tank serves to fill the tile lines and force the liquid to all parts of the reduction area. Time is also afforded between discharges to allow some aeration of the filter bed which should be of porous soil and gravel.

The automatic siphon has been used to obtain intermittent discharge. Since the use of the siphon involves several problems, a simpler means of securing the same results has been sought. Evidently such a device should be:

1. Reasonably permanent,
2. Low in cost,
3. Light in weight,
4. Easily secured or made, and
5. Simple to install,
6. Dependable, requiring little or no attention in operation.

A study to meet these requirements led to the double float valve which design is shown in the accompanying drawing. This device has been laboratory-tested, being operated the equivalent of 10 years use without failure. It has also been installed experimentally in several tanks. It is offered primarily for its low cost and ease of installation and to provide a device which may be manufactured or made locally. To construct it, requires little as to material, skill, or time.

Figure 1 shows the essentials of the valve in installation and operation. To install, no changes are necessary in the tank design as used for a number of years in extension work in this state except:

1. To provide a small sump below the valve,
2. To set the outlet pipe (1½" brass short nipple, coupling and 12" length of 1½" G iron pipe) on a level with the floor of the second chamber of the tank against the forms,
3. To set the anchor bolt to carry the valve (5" above outlet pipe), and
4. To install vent pipe.

The bill of material for making the valve as shown in the drawing; the tools required are vise, blow torch, wrench and pliers, and ¼" die, 20 threads per inch, for threading the ¼" rod. The bronze welding rod is readily bent to shape when heated and dimensions are such that extreme accuracy is not required. All the material used resists corrosion and should last many years.

To install the valve, a wood block carrying the anchor bolt is tacked to the forms directly above the outlet pipe. When the forms are removed the block is removed. The valve assembly is held in place on the anchor bolt and secured with a brass nut. The entire valve assembly

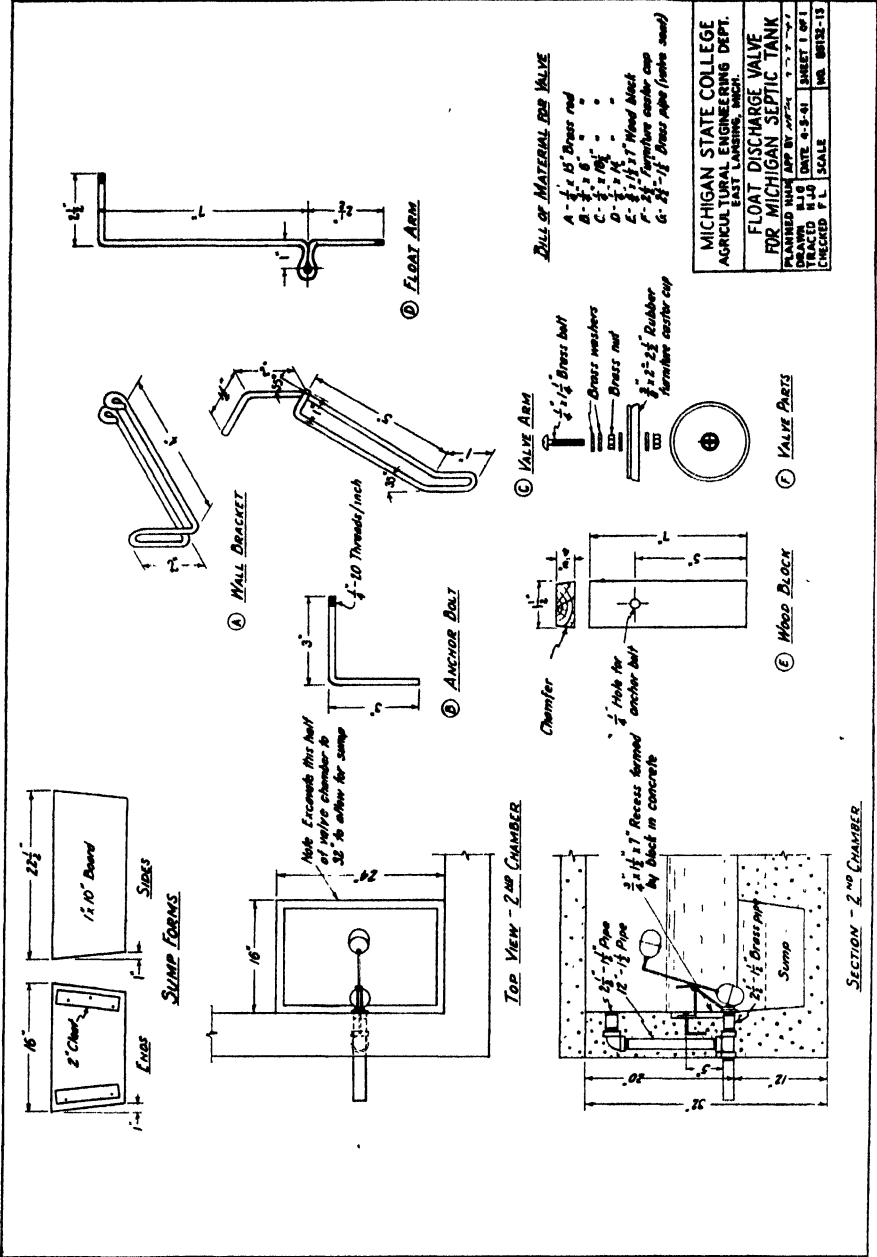


Fig. 1.

may also be easily removed for replacement if necessary. Adjustment is provided for aligning the valve with the outlet pipe.

In operation, the outlet pipe is closed by the rubber disk seating on the rim of the brass outlet pipe. With the outlet closed, the liquid rises, increasing the pressure in the outlet valve until the upper ball floats. The rise of the upper ball finally moves the lower ball past the vertical line through the pivot, when both lift, causing the upper arm to strike the valve arm and open the valve. With the pipe open the liquid rushes out, lowering the level until the lower ball again passes a vertical line through the center, and strikes the valve arm, closing the valve positively. The sequence of motions is then repeated.

The sludge sump is provided below the valve to prevent possible interference with the valve from this source. Other causes of slight leakage under the valve are probably not serious since the addition of a considerable amount of liquid at one time is sufficient to operate the valve. Even with excessive leakage or stoppage, which is unlikely, the tank would still function as a single chamber tank. Little hesitation need be felt in making use of this intermittent discharge device, which is economical and dependable.

The dimensions recommended for the septic tank serving a single dwelling is 3 feet wide, 5 feet deep and 5 feet long, inside measurements. The second or holding chamber is 2 feet wide, 20 inches deep and 5 feet long, and it is placed at the side of the first chamber. Where 6 inches of gravel is used under the tile in the disposal field about 125 feet of tile are required. It should be added that the disposal field should have good drainage to favor proper final breaking down of the sewage.

The foregoing presentation is intended to cover the essentials only of the septic tank and tile sewage disposal system, with a view to showing the function and purpose of the intermittent discharge valve described as one part of the system.

More complete information relative to the Septic Tank and Tile Sewage Disposal is contained in Extension Bulletin 118 (Revised), *Septic Tank Sewage Disposal Systems for Michigan*, which may be obtained from the county agricultural agent or the Bulletin Room, Michigan State College, East Lansing, Mich.

TENTATIVE SPRAY SCHEDULE FOR THE CONTROL OF INSECTS ON MICHIGAN ROSES

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SECTION OF ENTOMOLOGY

Several different kinds of insects attack roses; of these, comparatively few are of economic importance, the majority being either secondary or having no economic status. Since all insects differ from each other more or less in habits, life history, and methods of feeding, certain insecticides are effective against some species and not against others.

Insect-habits	Injury	Control	Comments
<p>Red spider, <i>Tetranychus telarius</i> L.—Small eight-legged mite. Color variable. Usually on under sides of the leaves protected by a silken web.</p>	<p>Feed on under sides of leaves. Injured foliage at first appears bleached—later turns brown and drops prematurely.</p>	<p>1. Dust, copper-roteneone; 2. Spray with bill posters' paste, two tablespoons per gallon of water. 3. Spray with glue—one tablespoon per gallon of water.</p>	<p>Observe precautions to cover the surface where the mites are established — particularly the under surface of the foliage.</p>
<p>Thrips—Several species.—Tiny, inconspicuous insects, about one-eighth inch in length. The young pale-green to bright orange; adults, black or green.</p>	<p>Mouthparts rasping. Feeding punctures give foliage a silver cast.—May blast opening buds.</p>	<p>Spray with tartar emetic. One ounce in three gallons of water, plus four ounces of brown sugar.</p>	<p>Apply spray as a mist, stop before spray drip — cover foliage.</p> <p style="text-align: center;">Tartar emetic is a violent poison</p>
<p>Aphids—Several species. Soft-bodied insects, winged or wingless, congregated on the tender growth.</p>	<p>Produce quantities of honey dew which serves as a media for sooty fungus. Lowers vitality of plant.</p>	<p>1. Spray with nicotine sulphate 40 per cent, one ounce in three gallons of water, plus one ounce of soap, or combine the nicotine with bordeaux (8-12-100). Pyrethrum sprays or dusts per manufacturers' directions.</p>	<p>Apply nicotine sprays immediately after combining. The bordeaux combination is particularly suggested where the leafhopper is also a problem.</p>
<p>Rose scale, <i>Aulacaspis rosae</i> Bouche.—The female covered with a conspicuous circular white shield scale. The male much smaller—narrow. Several generations each year.</p>	<p>Remove sap from stems; accumulate a quantity of honey dew usually accompanied by sooty fungus.</p>	<p>Cut out and burn old infested canes. Spray when dormant with oil three per cent.</p>	<p>Usually a problem where plants are grown in sheltered place.</p>

Rose leafhopper, <i>Empoasca rosae</i> L.—Breeds on rose and a number of deciduous trees and shrubs. Small pale green leafhopper about one-eighth of an inch long.	Feed on under surface of leaves, removing the sap. Injured area appears stippled. Injured foliage gradually dries up and drops prematurely.	1. Dust, copper-rotenone. 2. Spray, nicotine sulphate 40 per cent, one ounce in three gallons of bordeaux (8-12-100).	Both controls suggested are contact sprays and must come in contact with the insect to secure a kill.
Tarnished plant bug, <i>Ligys pratensis</i> L.—Adult a dull, bronze-colored bug about one-quarter-inch long. Wide range of host plants. Several generations a year. Winters as an adult under rubbish.	Sucks sap from tender leaves killing tissue in region of feeding puncture.	Dust, copper-rotenone. Dust, fortified pyrethrum.	Frequently migrates from weeds.—A problem on rose when growth is rank.
Four-lined leaf bug— <i>Poecilocapsa lineatus</i> Fab. Adult greenish-yellow with four black stripes running lengthwise of its body. Slightly over one-quarter inch in length. One generation a year—winters as an egg.	Mouthparts sucking. Kills plant tissue in vicinity of feeding puncture—Puncture usually isolated.	Dust, copper-rotenone. Dust, fortified pyrethrum.	A problem only on rank growth.
Leaf rollers—Several species. Larvae or caterpillars roll the leaves and feed inside the shelter.	Sometimes present in sufficient numbers to cut down food supply. Disfigure plant.	Use fortified pyrethrum dust or spray with lead arsenate one tablespoon per gallon of water, plus one pint of skimmed milk. Hand pick.	Difficult to control because they feed in protected places—may migrate from berry patches or wild briars to rose.
Rose beetle, <i>Macrodactylus subspinosus</i> Fab.—Adult beetle appears in late June and feed from four to five weeks. May occur in enormous numbers.	Adult feeds on flower and foliage.	Cover choice plants with cloth tents. Protect flowers with a fortified pyrethrum dust.	A problem on sandy soil. Adults may migrate in swarm for considerable distance.

Insect-habits	Injury	Control	Comments
Imported rose stem-girdler , <i>Agrilus communis</i> var. <i>rubicola</i> . Larvae make spiral tunnels under the bark—a tunnel may loop around the stem six to ten times—causing a gouty gall-like growth to develop.	Stem above the girdled area dies—may kill entire plant.	Cut out infested portions and burn.	May breed in raspberry—remove possible sources of infestation.
Raspberry cane-borer , <i>Oberia bimaculata</i> Oliv.—Adult beetle girdles the tender shoots with a double row of punctures about an inch apart and places an egg between the punctures.	The tip dies above the lower puncture and the young grub gradually works its way down to the roots.	Trim tips two to four inches below the lower girdle as soon as injury is discovered.	A common pest on raspberry and an occasional problem on rose—particularly climbing roses.
Rose curculio , <i>Rhynchites bicolor</i> Fab.—Small beetle about one-quarter inch long—deep red on back with a black snout.—Eggs are laid in the fruiting bodies.	Punctures the buds of roses—perforating the petals or blasting the buds.	Hand pick—cut and dispose of all fruiting bodies before the grubs are established in the ground.	Adult feigns death when the foliage is disturbed — often dropping to the ground and remaining rigid for several minutes at a time.
Rose midge , <i>Dasynura rhodophaga</i> Coq.—Adult a tiny fly. Eggs laid in small green buds or on tender growth. Twenty-five to thirty maggots may develop in one bud. pupate in soil.	Infested buds are either blasted or deformed. New growth deformed or stunted.	Do not force plants. Seldom a problem on tough slow-grown plants. Dust the infested soil with tobacco dust—leave undisturbed for 10 days or two weeks.	Seldom a problem in the garden.

<p>Rose slugs (Saw fly larvae).—Several species of green larvae about one-half inch in length.</p>	<p>Skeletonize the foliage or consume the entire leaf</p>	<p>1. Dust with copper-rotenone dust. 2. Dust with pyrethrum dust. 3. Spray with nicotine sulphate 40 per cent—one ounce to three gallons of soap suds—water—use immediately after combining. 4. Spray with lead arsenate one tablespoonful per gallon of water plus a pint of skimmed milk.</p>	<p>The choice of control measures depends upon the insect population where mites or leafhoppers are present number 1 is suggested; aphids, either number 2 or 3; rose chafers, number 2.</p>
<p>Spiny rose gall, <i>Diplolepis (Rhodites) bicolor</i> Harr.—Globular green or red galls—one-quarter to one-half inch in diameter—ornamented with stiff spines—Each gall contains a central cell inhabited by a hymenoptera larva.</p>	<p>Where the population is permitted to increase, the galls may be numerous enough to interfere with the food supply.</p>	<p>Hand pick the galls and burn.</p>	<p>Casual—spectacular.</p>
<p>Mossy rose gall, <i>Diplolepis (Rhodites) rosae</i> L.—Globose, densely spined, reddish-brown twig gall—one to one and a half inches diameter—made up of cells, each containing a larva.</p>	<p>Growth above gall killed; if neglected, population may build up sufficient to ruin stand.</p>	<p>Cut and burn while the gall is green.</p>	<p>Infestation usually restricted to individual plants.</p>
<p>Leaf cutter bees, <i>Megachile</i> sp.—Solitary bees—build their nests in hollow stems of various plants—partitioning off individual cells with leaf tissue.</p>	<p>Adults carve neat uniform semicircular patches out of either leaves or petals.</p>	<p>No control.</p>	<p>Adults valuable as pollenizers—while the beauty of the plant is marred, the vigor is not impaired.</p>

Insects with chewing mouthparts devour plant tissues and are usually controlled with stomach poisons, such as lead arsenate, calcium arsenate, paris green, or Hellebore. Insects with sucking mouthparts pierce the foliage; they are controlled with contact insecticides, such as nicotine, rotenone or pyrethrum. Since only small quantities of insecticides are required at any one time, the application is usually made with a hand atomizer, a small pressure knapsack sprayer, or a hand dust gun. It is, therefore, necessary with most of the contact sprays to increase the amount of killing agent used.

The following tentative schedule is suggested for control of the common pests of Michigan roses. Where possible, several methods of control are suggested; the choice should be governed by a consideration of the treatment which will be the most satisfactory under the circumstances.

Bordeaux mixture is a repellent for certain insects, such as leaf-hoppers and plant bugs. To prepare an 8-12-100 bordeaux in small quantities, dissolve two ounces of copper sulphate in one gallon of water. Mix three ounces of hydrated lime (calcium hydroxide) in another gallon of water and pour the one gallon of copper sulphate and the one gallon of lime water into a gallon of water. This gives three gallons of robinsegg blue bordeaux mixture.

A number of commercial dusts are sold which combine bordeaux dust with insecticides. A very effective homemade combination is prepared by using eight parts lime plus two parts monohydrated copper sulphate. Where it is desirable to check leaf-feeding beetles, the addition of calcium arsenate is suggested.

POLE-STACKS FOR CURING HAY IN THE UPPER PENINSULA

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SECTION OF FARM CROPS

Tame hay is the largest crop of the Upper Peninsula; more than 12,000 acres of alfalfa and 230,000 acres of timothy, or a mixture of timothy and clover are grown yearly.* Quack grass is prevalent in much of the hay. In recent years the hay mixture of alfalfa, alsike and timothy has been recommended, and is being grown to some extent.

The problem of producing high-quality roughage is very important in this region. Each year a large amount of hay is damaged or totally lost because of rain during the haying season. In 1940, the Station at Chatham lost 25 acres, one-fourth of the total acreage of first cutting hay, because of adverse curing weather. The prevailing weather at Chatham is comparable to most sections of the Upper Peninsula. The data herein presented have been obtained from experiments and observations made at the Upper Peninsula Experiment Station at Chatham.

*Figures from the Michigan 1935 farm census report.

The production of high-quality hay is made difficult by the high percentage of rainy days and low mean temperature during the haying season, as shown by Table 1. The most favorable curing period for first-cutting hay is from July 11 to July 20, which is too late from the standpoint of producing hay of highest nutritive value. Alfalfa, if cut in the early bloom stage, will be cured from June 20 to 30. Timothy and clovers, if cut in the early bloom stage, will be cured from July 1 to 10. Most second cuttings are made from September 1 to 20, during which period one-half of the days are rainy and the weather is so cold that drying is slow.

Table 1. The average mean temperature and average per cent days with rain during the hay curing periods at the Upper Peninsula Experiment Station 1936-40.

Curing periods	Average mean temperature	Average percentage of days with rain
	°F.	per cent
June 20-30.....	62	40
July 1-10.....	68	34
July 11-20.....	67	30
July 21-31.....	67	38
Aug. 1-10.....	69	56
Aug. 11-21.....	68	38
Aug. 21-31.....	63	47
Sept. 1-10.....	61	44
Sept 11-20.....	58	56
Sept 21-31.....	54	34

The number of rainy days during the haying season does not indicate all the difficulties of curing hay in the Upper Peninsula. The low mean temperature, averaging 64° F. for the ten curing periods, prevents rapid curing of hay. In 1939 and 1940, 50 per cent of the days in July were cloudy or partly cloudy. Hot, dry, windy weather is not prevalent in this region. Heavy dews in the morning delay curing and haying operations to a considerable extent.

The "Pole-stacking" System

For a number of years a few Upper Peninsula farmers of the Scandinavian descent, have been using a "pole-stacking" system for curing hay during adverse weather conditions. In 1940, experimental work was conducted at the Upper Peninsula Experiment Station using this system for curing first and second cutting hay.

Trees, about three inches in diameter, were cut to make poles seven to eight feet long. Stubs of branches were left on to make prongs an inch or two in length. Boards four feet long were nailed to the poles about a foot and a half from the larger end, as shown by the diagram. An iron bar was used to make small holes in the ground in which the larger end of the poles were placed firmly, allowing the attached boards to rest on the ground. This gave the poles sturdy support and allowed circulation of air at the base of the stacks. The other end of the poles was pointed, which aided in proper construction of the stacks. Prongs were left on the poles to prevent the hay from settling too tightly around them. Spikes driven into the poles at alternate places would

have served the same purpose. Projections of some sort are essential to keep the center of the stacks from packing too tightly.

Construction of a Stack

Loose hay from the windrow was piled around the pole, each fork load overlapping, requiring four fork loads to make a tier around the pole. (The hay should not be rolled and put into the stack in a tight bunch.) The hay was piled in tiers to a foot from the top of the pole, and from then on it was put directly on top, forcing some hay down around the pole which gave strength to the stack. About two feet of hay was put directly on top of the pole, creating a water-shedding cap. This type of construction allowed the air to circulate through the stack curing the hay.

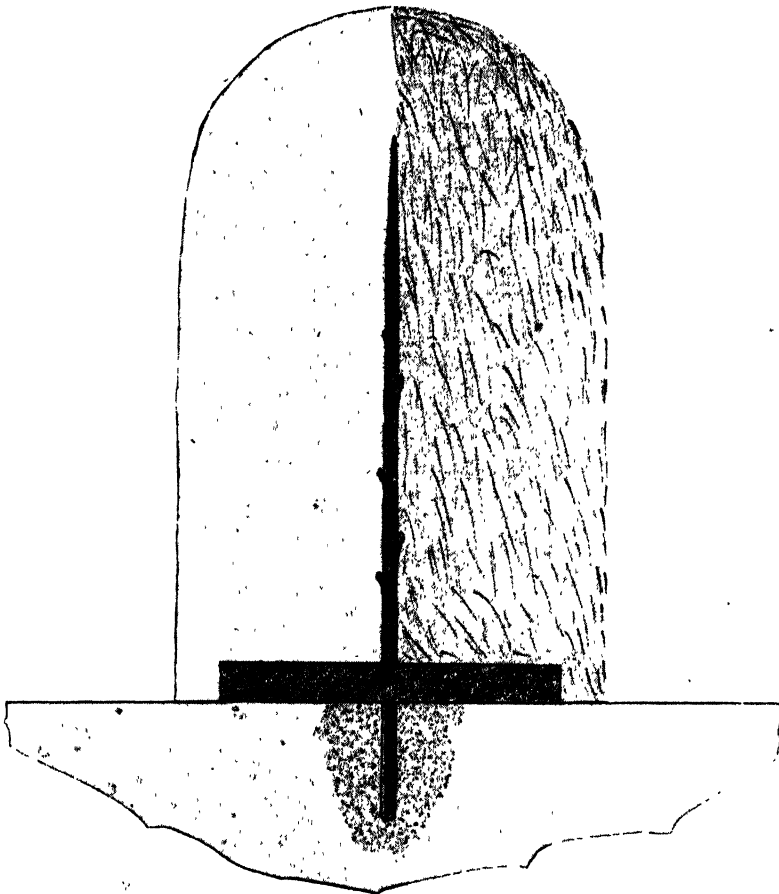


Fig. 1. Diagram of a pole-stack, showing the position and construction of the pole and stack.

Dimensions: Pole—6' above the ground, 1½' in the ground, and 3" in diameter. Prongs on pole—1"-2" long. Stack—8' high and 5' wide at the base. Board—4' x 6" x 1".



Fig. 2. A well built stack. The sides are straight up and down. This type of stack allows proper circulation of air throughout resulting in rapid curing.

The stack should not settle below the top of the pole. If it does, rain water will run down the pole, wetting the hay in the center of the stack. It was found that one man could work to better advantage than two. Two men will not place the hay uniformly on the stack and it becomes oversized or settles unevenly. Extra men can be used in bringing the hay to the man doing the stacking.

It was evident from observation and experimental results that a stack should not be built more than 5 to 5½ feet in diameter, and it should be at least 7 to 8 feet in height. The bottom of the stack must be kept narrow as this part of the stack settles into a firm mass. The sides of a well-built stack are straight up and down.

Experimental Results—1940

The experimental results and observations at the Upper Peninsula Experiment Station indicate that **green** hay, free from external moisture (rain or dew), averaging from 50 to 60 per cent internal moisture can be cured during adverse weather conditions with a very slight loss in quality.

A curing experiment with a second-cutting hay mixture of alfalfa, alsike and timothy was conducted using pole stacks and average sized cocks. The hay was cut in the morning after the dew had disappeared and was promptly put in windrows with a side-delivery rake. Three hours after it was cut, part of the hay was pole stacked and part was



Fig. 3. A poorly built stack. This stack is too large at the base, preventing proper air circulation.

cocked. The moisture content of the pole stacked and cocked hay was 51 and 43 per cent, respectively. Fourteen days, of which seven were rainy, were required to cure the pole stacked hay to a 19-per cent moisture content. None of the hay was spoiled. The cocked hay at the end

Table 2. Comparison of second cutting hay before and after pole stacked and cocked.

Condition and analysis of hay*	Stack 1		Stack 9		Stack 12		Cock 13	
	Before	After	Before	After	Before	After	Before	After
	**		***		†		†	
Moisture (%)	72.04	19.7	60.25	18.4	51.34	18.91	42.23	26.46
Good hay (%)	100.00	37.9	100.00	51.4	100.00	100.00	100.00	84.00
Protein (%)	14.55	14.20	13.97	12.99	12.82	12.72	12.97	13.16
Ash (%)	7.63	7.01	6.90	6.63	7.00	6.83	6.64	6.53
Ether extract (%)	3.05	2.97	2.80	1.99	3.06	2.65	2.88	2.45
Crude fiber (%)	37.19	36.12	37.53	36.37	35.33	36.37	36.85	37.07
N. F. E. (%)	37.58	39.70	38.71	41.82	41.79	41.43	40.66	40.79
Carbohydrates (%)	74.77	72.82	76.24	78.39	77.12	77.80	77.51	77.86
Carotene mg/100 gms. (%)	5.63	6.14	4.41	5.06	5.81	5.12	5.60	3.83
No. of curing days...	34		34		14		14	
No. of days with rain...	20		20		7		7	

*Good hay.
**Green hay with dew.
***Green hay with dew. Wilted for 1 hour.
†Green hay free of dew. Wilted for 3 hours.

of the 14-day period contained 27 per cent moisture with a spoilage of 16 per cent. Experimental results are given in Table 2, comparing hay before and after pole-stacked and cocked.

In the same year, 10 acres of a 14-acre field of first cutting hay was cured in pole-stacks and the remaining four acres in average-sized cocks. Part of the hay which was pole-stacked was free from external moisture, while part was stacked when still wet with rain. The hay that was slightly wilted and free from external moisture, cured in two weeks, resulting in good quality hay with the green color and leaves retained. The hay that was slightly wilted but with external moisture when stacked was not cured at the end of the two weeks. Although the top halves of the stacks were cured, the bottom halves were moldy and wet. It was possible to save the top half of each stack, but the bottoms were discarded as of no feeding value. The four acres of hay which had been cocked was first partially cured in windrows and then put in average-sized cocks and left there two weeks before it was hauled. Much of this hay was black with extensive loss of leaves, moldy and of no feeding value. Seven of the fourteen days during which time the above hays were being cured were rainy.

It required ten hours for six men to make the poles and stack the 10 acres of hay mentioned above, averaging 2 tons per acre cured. On the basis of 27 cents per hour per man, the cost to pole-stack the hay was \$0.81 per ton. On most farms in the Upper Peninsula where pole-stacking is applicable, the cost of making the poles is a very minor part of the total cost of the haying operation. The poles can be made in the winter when work is not pressing. Further work will be conducted in the future to determine the cost of pole-stacking versus cocking of hay.

Conclusion

1. Hay to be cured in pole-stacks may average from 50 to 60 per cent moisture, but should be **free** of dew and rain.
2. The stacks should be constructed as follows:
 - (a) Use strong wood poles about three inches in diameter at center, with prongs.
 - (b) Set the poles firmly into the ground, supported with boards.
 - (c) Arrange **loose** hay around the poles.
 - (d) Keep the stacks 5 to 5½ feet in diameter. Over-sized stacks result in moldy hay.
 - (e) Keep the sides of the stacks straight up and down.
 - (f) Build well over the top of the poles so that they will not stick out after the hay has settled.
3. Eight to ten stacks are equivalent to one ton of hay containing 20 per cent moisture.
4. Curing hay in well constructed pole-stacks eliminates much of the weather hazard at haying time.
5. The cost is small as compared with spoilage losses in bad weather.

A TEAT CUP SOLUTION RACK

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SECTION OF AGRICULTURAL ENGINEERING

J. M. JENSEN

SECTION OF DAIRY HUSBANDRY

The result obtained in producing high-quality milk with a milking machine is frequently the determining factor in regard to its continuous use on many farms. There can be no doubt that the milking machine must be cleaned and sterilized with more thought and care than any other piece of milk producing equipment. This is true because of the many parts involved.

Keeping the rubber parts in good condition can apparently best be done by keeping the rubber tubing clean and full of a dilute lye solution between milkings. Dirt and fats deteriorate rubber, making it sticky and porous and thus a harbor for bacteria. A lye solution of 0.4 per cent concentration will remove the fat and keep the rubber clean and firm.

The teat cups and rubber milk tubing can be completely submerged in a large container filled with the lye solution or they may be hung upon a suitable rack and completely filled with a fresh solution. Both methods give satisfactory results if properly used. When using the submersion method the solution gets weaker each day and should be discarded daily. When using the teat cup solution rack method the teat cups and tubes are filled with a small quantity of fresh solution which is known to be effective. Over a period of time less solution will be required by this method than would be required by the submersion method to give equal protection. The more economical use of the lye solution, together with the knowledge that the small quantity used is fresh each time and can be depended upon, makes the teat cup solution rack a desirable aid to producing quality milk.

The wooden solution rack illustrated in Fig. 1 is neat and serviceable. It provides a convenient place for storing a stoppered bottle or jug

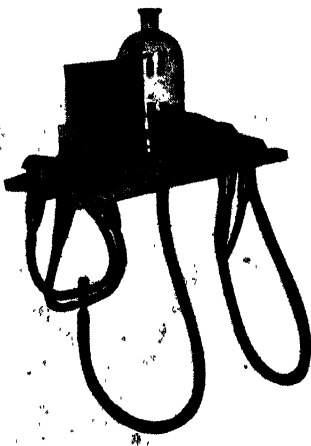


Fig. 1. A simple teat cup solution rack in use.

of the 0.4-per cent solution of lye. Furthermore it may be made by the high school boy in his farm shop class or in 4-H club work with very little expense for materials.

Materials Needed

Back: 1—1" x 8" board 12" long
 Shelf: 1—1" x 8" board 11" long
 Side braces: 2—1" x 4" boards 12" long
 Slats: 3— $\frac{1}{4}$ " x $1\frac{1}{2}$ " boards 20" long

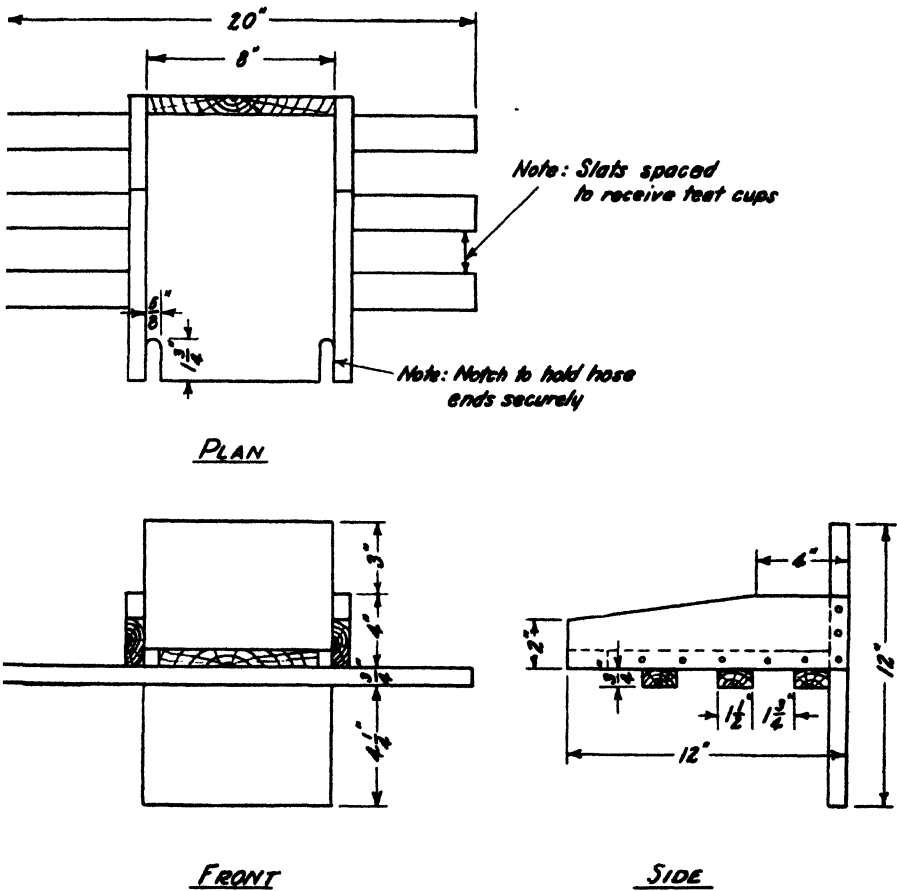


Fig. 2. Construction details of the solution rack.

For details of construction see Fig. 2.

The spacing between the slats may need to be changed slightly to fit the teat cups of some milking machines. The width of the notches should be such that they will securely hold the milk tubes in place.

Cleaning the Milking Machine

The cleaning procedure for milking machines usually recommended by the Dairy Department of Michigan State College employs the following steps:

A. Following each milking:

1. Suck one to three gallons of clean cold water through each unit; while doing so dip the teat cups into and out of the water to cause a scrubbing effect by the water rushing through the cups and rubber tubing. Rinse the milker-pail and discard the water.
2. Suck $1\frac{1}{2}$ gallons of scalding water through each unit. The temperature of this water should not be less than 165° F.
According to Mallmann* the addition of sodium metaphosphate detergent (1 oz. to 1 gallon of water) to this scalding water will prevent milk stone and water hardness deposits in the rubber tubes and on the metal parts.
3. Wash the pail with hot water and washing powder, using a stiff bristle dairy brush. Rinse with hot water to remove all traces of washing powder, drain and invert to dry.
4. Disconnect the milk tube from the head and wash the head in the same manner as the milker-pail. Do not overlook the check valve.
5. Hang the milk tube and teat cups on a suitable rack and fill with 0.4-per cent lye solution or submerge in a container of the lye solution. In either case the teat cups and milk tubes remain filled with the lye solution until the next milking.

B. Before milking:

1. Drain out and discard the lye solution in the teat cups and tubes.
2. Suck two gallons of clean chlorine solution (50 ppm.) through the assembled unit.

Removal of Deposits from Milk Tubes

A milking machine which has not been cleaned regularly by the preceding method may be coated with a deposit. This deposit can be removed by placing the rubber parts and claw into a lye solution made by adding one pint of stock solution to one gallon of water and heating to the boiling temperature. Allow the solution to cool then remove the parts, rinse them in clean water and reassemble. This heat treatment with lye removes any grease adhering to the rubber parts, destroys any bacteria present, and prolongs the life of the rubber.

Preparation of Lye Solution

Use one 13 oz. can of lye plus one gallon of water for stock solution.

Add 6 oz. of stock solution to one gallon of water for a 0.4 per cent solution.

*The Value of Sodium Metaphosphate in Detergent Mixtures in the Cleaning of Milking Machines—*Jour. Dairy Science*. 23 (7): 621-627. 1940.

BULLETIN REVIEWS

Circ. Bul. 177—Peach Culture in Michigan—Johnston, S., Hutson, R. and Cation, D.—A comprehensive discussion of the cultivation of the peach in Michigan, including: sites, soils, varieties, planting, pruning, soil management, thinning, harvesting, insects and diseases. (86 pp., 3 tables, 56 figs., 4 color plates.)

Tech. Bul. 174—The Development of Mold on Cold Storage Eggs and Methods of Control—Mallmann, W. L. and Michael, Catherine E.—When eggs are placed in cold storage, the humidity is kept down to prevent the formation of moisture on the eggs and the container. The reduced humidity causes a loss of moisture from the eggs and a resulting reduction in quality.

A study of the molds occurring on storage eggs was made. Out of a total of 400 isolations, 214 were *Penicillia*, 50 strains were *Aspergilli* and 80 were *Mucors*. There was no relation between the place of storage or season and species.

A mycostatic agent, sodium pentachlorophenate, was applied to the fillers, flats and cases to control mold growth. It was found that, at even high humidities, at 31° F. mold growth was prevented on fillers flats, cases and the shell of the egg. (34 pp., 23 tables.)

Tech. Bul. 175—Landform Types, A Method of Quantitative and Graphic Analysis and Classification—Wolfanger, L. A.—Although the serviceability of quantitative analyses as research tools has long been recognized, the identification and differentiation of landforms or surface configuration have been largely restricted to either genetic factors or qualitative descriptions. The characterization of a surface as a "maturely dissected plateau" or "strongly rolling hill country," however, is not sharply definitive without the support of quantitative analyses that set forth the relative magnitudes and frequencies of the forms and elements involved.

A simple quantitative method is proposed which determines the proportion and mean length of the several gradient classes comprising a given surface configuration, and employs these means for the development of a "mean landform graph." This graph, taken either as a whole or in its individual elements, offers a variety of measurable relationships, such as a "relief index," a "basal index," a "steepness index," and a "landform index" that may be used as basis for quantitative comparisons.

The method is applicable to analyses at any level of magnitude (to small local areas as well as to large natural regions) and to land areas located in widely separated parts of the earth. It may be utilized for comparisons of closely related landforms or those of contrastive character. The general procedure could also be employed for the analysis of measurable elements of land other than gradients or slopes. A system of classification based upon this type of analysis is suggested, including a system of nomenclature. The utility of landform indices and maps based upon such indices to both land use studies and scientific investigations of a geographic or geomorphologic character are briefly discussed. (24 pp., 5 figs.)

Tech Bul. 176—The Detection, Distribution and Mobility of Certain Elements in the Tissues of Plants Growing under Different Conditions as Determined by the Spectrographic Method—Hibbard, R. P.—The modern spectrographic technique for the determination of certain elements in plant tissues can now be applied with greater accuracy. A way is thus opened for a better knowledge of the mobility, distribution and the role of elements in the physiology of the plant. Potassium is easily water-soluble and was not found in the ether extract or the residue and therefore it is improbable that it occurs in more complex organic combinations than that of salts of certain organic acids. The five other elements examined—calcium, magnesium, phosphorus, iron, and manganese—all gave evidence of the formation of ion-organo compounds which accounts for their varying degrees of immobility. Immobility is not a matter of chemical precipitation or modified permeability but one of energy exchanges, protoplasmic activity and other vital processes. Short-day conditions slow up total salt absorption while full-light favors greater transfer of calcium, iron and potassium while phosphorus appears indifferent. The effects of solutions deficient in one element or another are not entirely a matter of solution imbalance, reciprocal relationship or impaired permeability but to metabolic reactions attendant upon the plant's activity. The result is rather a different rate and quantity of absorption than in a physiologically balanced salt solution. Calcium, magnesium and iron predominate in the leaves, phosphorus in the roots and young leaf tissue while potassium is abundant in the stems. The functions of these elements, wherever they may be found, is more easily determined by their detection in definite places at certain times, than by any method of discovery where greatest accumulations have taken place. (30 pp., 8 tables, 1 fig.)

JOURNAL ARTICLE ABSTRACTS

Chloropidae (Diptera) of the Oriental Region: Notes and Synonymy—Sabrosky, C. W.—Annals and Magazine of Natural History (London, England). (Series 11) 6: 418-427. 1940. [Journal Article No. 402 (n. s.) from the Michigan Agricultural Experiment Station.]—The paper includes a number of miscellaneous items on the classification of certain small flies from southeastern Asia and the East Indies. The work was based on material sent to the writer for determination by the Imperial Institute of Entomology, London, England.

A Study of the Reducing System of Milk—Gould, I. A.—Jour. Dairy Sci. 23 (10). 977-989. 1940. [Journal Article No. 427 (n. s.) from the Michigan Agricultural Experiment Station.]—The KIO_3 titer of milk was found to be decidedly higher than it would have been had ascorbic acid been the sole contributor. Ascorbic acid was found to contribute approximately from 30 to 60 per cent of the KIO_3 values with the majority of samples giving values falling within 30-40 per cent. Copper and sunlight reduced the KIO_3 values, the reduction apparently being due entirely to destruction of ascorbic acid. Iodoacetate slightly lowered the total KIO_3 values but did not affect the ascorbic acid content. Re-

duction of the sulfosalicylic acid filtrate with zinc dust had no appreciable influence on the KIO_3 titer. Heating milk to 70° C. did not affect the KIO_3 values, but temperatures of 80° C. or above decreased the values. The 2-6 dichlorophenolindophenol values were not influenced by the temperatures used, indicating that the heat treatment affected the non-ascorbic acid portion of the materials responsible for the KIO_3 titer.

Protective Influence of Glutathione on Copper-induced Oxidation of Ascorbic Acid in Milk—Gould, I. A.—*Jour. Dairy Sci.* 23 (10): 991-996. 1940. [Journal Article No. 428 (n.s.) from the Michigan Agricultural Experiment Station.]—Glutathione was added to milk in quantities of 25 and 15 mg. per cent. The milk had previously been heated to 80° C. to prevent normal disappearance of the GSH. A portion of the milk was treated with 1.5 p.p.m. of copper and the ascorbic acid and GSH determined at intervals of 15 min., and 1, 2, 4, 6, 24 and 48 hours. Twenty-five mg. per cent of GSH stabilized the ascorbic acid against copper-induced oxidation, but it was itself partially destroyed. Approximately 60 per cent of the reduced GSH had disappeared by the close of the storage period, whereas the ascorbic acid remained substantially unaltered. In the lot which contained no GSH but 1.5 p.p.m. copper, the ascorbic acid was completely oxidized after 24 hours. Similar results were obtained when 15 mg. per cent of GSH were used.

The Disappearance of Added Glutathione in Milk—Gould I. A.—*Journ. Dairy Sci.* 23 (10): 985-989. 1940. [Journal Article No. 429 (n.s.) from the Michigan Agricultural Experiment Station.]—Fifty mg. per cent of glutathione were added to milk and the KIO_3 titer determined after 15 minutes, 1 hour, 2 hours, and 4 hours of incubation at 20° C. When raw milk was used, the glutathione disappeared rapidly. From 20 to 35 mg. per cent of reduced GSH remained after 1 hour, approximately 10-15 mg. per cent after 2 hours, and 2 mg. per cent or less after 4 hours. Slightly higher values were secured in milk serum than in whole milk, but the relative loss during incubation was approximately the same. Only a small portion of the GSH which disappeared was in the oxidized form, especially during the first 2 hours of incubation. Heating milk to 80 or 90° C. prior to adding the GSH completely stabilized the tripeptide, whereas 70° C. only partially prevented its disappearance.

Effect of Cooking upon the Vitamin B₁ Content of Two Types of Beans Grown in Michigan—Kelly, E. and Porter, T.—*Food Research.* 6 (1): 85-93. 1941. [Journal Article No. 432 (n.s.) from the Michigan Agricultural Experiment Station.]—Two types of beans, the Michelite and the Cranberry, were boiled or baked according to standard procedures which would yield tender products. These kinds of beans were selected for cooking because they were considered of special interest to Michigan growers. The Michelite variety, first released for commercial production in 1937, possesses a number of desired characteristics along with a resistance to mosaic and other diseases. The light Cranberry bean is large, with a tan seed coat mottled with red and is rather dark colored when cooked. This bean has been growing in popularity with consumers.

The boiling and baking processes employed in this experiment resulted in cooked beans which were estimated to have more available vitamin B₁ than the same beans in the raw state as determined by the rat-growth method. The cooked Michelite beans had a Vitamin B₁ content ranging from 2.3 to 3.0 I.U. per gram of dry beans; the cooked Cranberry beans, from 1.9 to 2.9 I.U. per gram. Both varieties showed vitamin B₁ values below 1.7 I.U. per gram when raw.

Very little if any loss of vitamin B₁ resulted from discarding the water in which the beans were soaked over-night. Soda, used as a softening agent during soaking but thoroughly rinsed off before cooking, shortened the boiling time from 5 to 15 minutes but did not cause a destruction of vitamin B₁. Somewhat less vitamin B₁ value was present in baked beans than in boiled beans.

Determination of Carotene in Plant Material. Dicalcium Phosphate as an Adsorbent.—Moore, L. A.—Ind. and Eng. Chem. (Analytical Edition.) 12: 726-729. 1940. [Journal Article No. 438 (n. s.) from the Michigan Agricultural Experiment Station.]—A method for the determination of carotene in plant material is outlined which consists essentially of extraction with alcohol, extraction of the alcoholic extract with petroleum ether, removal of alcohol from the petroleum ether, and passing the extract through a Tswett column of dicalcium phosphate. By this method certain noncarotene chromogens are removed, so that the value obtained is probably for pure carotene.

These results indicate the Willstätter-Stoll method or its modifications for the determination of carotene are not accurate for plant material which has been subjected to storage or to the action of the digestive tract.

Effects of Periods of Warm Weather upon the Winterhardened Condition of a Plant—Dexter, S. T.—Plant Physiology. 16: 181-188. 1941. [Journal Article No. 440 (n. s.) from the Michigan Agricultural Experiment Station.]—The severed roots of alfalfa and entire plants of alfalfa and winter wheat were exposed to alternate periods of low and high temperatures, suitable for "hardening" and for growth, respectively. Several alternate hardenings and dehardenings to cold of severed alfalfa roots are possible, particularly with roots dug in the fall. When such alternations of temperature occur in the field in late winter, rehardening occurs to a limited extent but is lessened by growth of new shoots. With winter wheat, successive rehardening is possible in unvernallized plants (in early winter), but with vernalized plants (in the spring) rehardening is less likely, although it may occur if not much growth occurs during the interval of warm weather. A long day, with warm weather (as in March or April), is particularly likely to induce growth in vernalized winter wheat, with resultant loss of ability to reharden to cold. Retention of the ability to reharden following intervals of warm weather in late winter is not particularly characteristic of varieties of wheat that can endure low temperatures. When the plant is well-stored with food and when previous and present weather conditions are such as to maintain a condition of dormancy, with consequent conservation of this food, then periods of warm weather are not particularly damaging to winter-hardiness. Periods of warm weather are, in general, more likely to cause damage if followed by cold in the spring than in the fall or winter.

A Solution of Normal Equations Giving Standard Errors of the Constants—Baten, W. D.—*Jour. Agr. Res.* 61 (6): 237-240. 1940. [*Journal Article No. 452* (n. s.) from the Michigan Agricultural Experiment Station.]—This paper shows how to solve simultaneous normal linear equations so as to obtain values which can be used in finding the standard errors of the constants. The method consists of successive divisions, subtractions, substitutions, and keeping certain product summations intact. The method used is easy to follow and easy to teach computers using modern computing machines.

The Effect of the Quantity of Basal Food Intake upon the Utilization of Vitamin A—Kelly, E. and Muelder, K. D.—*Jour. Nutrition.* 21 (1): 13-24. 1941. [*Journal Article No. 457* (n. s.) from the Michigan Agricultural Experiment Station.]—The quantity of food consumed as it affects the utilization of vitamin A in the body was the subject of an investigation in which 237 white rats were used as test subjects.

In this experiment the animals were divided into three main groups: those in group A were allowed all they wanted to eat of a basal diet adequate in all respects except vitamin A; those in group B were given the same amount of the basal diet plus graded amounts of vitamin A; and those in group C were given the same amounts of vitamin A as group B and as much of the basal diet as they chose to eat. On the same level of vitamin A intake, those animals eating additional calories made increased gains in weight, the added gain in weight being directly proportional to the larger amount of food consumed. Also, as the level of vitamin A was increased the general well-being of the animal and the utilization of the food consumed was improved sufficiently so as to give increased percentage gains in weight at each increase of vitamin A intake.

Vitamin A not only aids in normal growth but is also concerned with protection against infection by helping to maintain healthy tissues free from infected areas. Tabulation of the number of "abscessed" areas among the three groups of animals indicated some advantage of unrestricted (group C) as compared with restricted (group B) food intake at the highest level of vitamin fed (6 International Units) in protecting against infection. All animals fed vitamin A (groups B and C) showed marked protection against infection at either the 1, 3, or 6 unit levels of vitamin intake over those animals (group A) receiving no vitamin A, as indicated by the reduction in number of "abscessed" areas exhibited.

X-Ray Studies on the Field Bean—Genter, C. F. and Brown, H. M.—*Jour. Heredity.* 32: 39-44. 1941. [*Journal Article No. 461* (n. s.) from the Michigan Agricultural Experiment Station.]—Lots of dormant and germinated (for 18 and 36 hrs.) seeds of Michelite white pea beans (*Phaseolus vulgaris*) were x-rayed with four dosages: 2160, 6500, 13000 and 26000 r-units. Of the 1434, second generation, progenies grown from treated seed, 150 showed mutations which were classified in 32 types. Ninety per cent of the mutants were distinguishable within five weeks after emergence and of these 67 per cent were chlorophyll abnormalities. Other characters affected were: plant size, branching, leaf size, shape and texture, fertility, and earliness of maturity. The rate of mutation varied roughly with dosage and length of germination

period prior to treatment and tended to increase with the later harvest dates and with size of progeny. The great variability of the mutant ratios indicated that the x-rays affected only limited sectors of the treated embryos rather than the entire embryos.

Blood Sugar and Carbon Dioxide Combining Power of Plasma in Relation to Ketosis in Dairy Cattle—Sykes, J. F., Duncan, C. W. and Huffman, C. F.—*Jour. Dairy Sci.* 24 (3): 193-197. 1941. [Journal Article No. 462 (n. s.) from the Michigan Agricultural Experiment Station.]—In a study of ketosis, the total ketones of the blood, blood sugar and carbon dioxide combining power of the plasma have been determined on a large group of mature dairy cattle. Some of these were made at weekly intervals over considerable periods. With one or two exceptions, clinical symptoms of ketosis were not evident. With increasing degrees of ketosis, the blood sugar values progressively decreased, although all these values fell within accepted normal limits. The carbon dioxide combining power of the plasma remained within normal limits at all levels of blood ketones which were encountered in this particular group of cattle and showed no consistent variations that could be correlated with the degree of ketosis.

Iron Balances on Four Normal Pre-School Children—Porter, T.—*Jour. Nutrition.* 21: 101-113. 1941. [Journal Article No. 464 (n. s.) from the Michigan Agricultural Experiment Station.]—The iron metabolism of four normal pre-school children was studied for a period of 63 days. These children were fed a constant, weighed diet of foods commonly relished by youngsters of that age, including milk, meat, eggs, fruits, vegetables and cereal products. The average quantity of iron in the diets was found to be 5.64 mg. per child per day.

On this iron intake varying amounts of the mineral were stored, ranging from a state of practical equilibrium to 2.90 mg. of iron per day. The average iron storage of these children was about one and one-fourth milligrams per day; this storage represented approximately 22 per cent of the intake of iron. These small quantities of iron seemed to be adequate for the children in this study while they were receiving a diet judged adequate in all other essential nutrients.

The Effect of Varying Conditions on Oviposition by *Trichogramma* on Eggs of Angoumois Grain Moths—Costas, L. A.—*Jour. Econ. Entom.* 34 (1): 57-58. 1941. [Journal Article No. 477 (n. s.) from the Michigan Agricultural Experiment Station.]—A recountal of laboratory breeding experiments with *Trichogramma minutum* Riley. The results presented in tabular and discussion form indicate the influence of environment on egg deposition by *Trichogramma*. The more important effects appear as increasing effectiveness in parasitizing eggs of Angoumois grain moth as temperature rises, light intensity increases and the number of eggs per parasite available becomes smaller. Freshness of eggs and the presence of sulphur upon the eggs and darkness markedly decreased parasitism.

Studies upon the Relation of Nutrition to the Development of Necrotic Enteritis in Swine. II. Nicotinic Acid, Yeast and Liver in the Prevention of Necrotic Enteritis in Young Pigs Fed Massive Doses of *S. choleraesuis*—Davis, G. K. and Freeman, V. A.—*Proc. Am. Soc. An.*

Prod., pp. 316-323. 1940. [Journal Article No. 488 (n.s.) from the Michigan Agricultural Experiment Station.]—Results are reported of a series of four experiments run during the spring and summer of 1940 in which 101 pigs ranging in age from 5 to 10 weeks were used. The pigs were given cultures of the *Salmonella choleraesuis* organism, varying in amounts from 30 to 100 cubic centimeters of a 48 hour meat infusion broth.

Although nearly all of the pigs fed the culture showed an initial reaction, as indicated by the rapid rise in temperature and loss of appetite, there were marked differences in the reaction of the pigs, as indicated by the development of necrotic enteritis, weight change and mortality.

Yeast in the amounts fed (30 to 70 grams) gave no better results than where no supplementary feed was given. Nicotinic acid (100 grams) was effective in most cases in preventing the development of necrotic enteritis but there was no appetite stimulation and the pigs fed this supplement failed to gain properly following the initial reaction from the culture of the organism. Fresh beef liver fed at the rate of 120 grams per day again proved to be the best supplement in that it not only prevented the development of necrotic enteritis in most cases but also served to stimulate the appetite of the pigs with a resultant weight gain.

Recoveries of the organism were made from these pigs and it was definitely ascertained that the organism was present in the intestines and in many cases in the bile.

Uses of a Lauryl Sulfate Tryptose Broth for the Detection of Coliform Organisms—Mallmann, W. L. and Darby, C. W.—Am. Jour. Pub. Health. 31 (2): 127-134. 1941. [Journal Article No. 490 (n.s.) from the Michigan Agricultural Experiment Station.]—The proposed medium contains tryptose, which was added to increase the rate of growth of the coliform organisms. The phosphate salts and sodium chloride were also found to increase growth rates, and so they were included in the formula. The sodium lauryl sulfate in a dilution of 1 to 10,000 acts as a bacteriostatic agent to the Gram-positive bacteria, but it has no inhibitory effect on Gram-negatives. This medium when used as a primary medium in the detection of coliform organisms from water supplies always confirmed if gas was produced.

Boning, Curing and Smoking Poultry Meat—Schaible, P. J. and Davidson, J. A.—The U. S. Egg and Poultry Magazine. 47 (4): 228-230, 255, 256. 1941. [Journal Article No. 508 (n.s.) from the Michigan Agricultural Experiment Station.]—Methods developed at this station and elsewhere, are described and discussed with relation to the size and practicability of the enterprise. Principles underlying the use of chemicals in the curing operation are stated. It is pointed out that smoked poultry meat has important potentialities for the poultry and meat packing industries.

NATURE OF PUBLICATIONS

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TECHNIQUES AND TOOLS FOR DETERMINING THE PHYSICAL PROPERTIES OF SOILS

The important physical properties of soils and clays have long been recognized and these materials have been utilized in various ways in agriculture, horticulture, and in industrial processes, as in the manufacture of brick and pottery, since time immemorial. Only in comparatively recent times, however, have intensive studies been made on the texture, structure and other physical properties of soils and their relationships to soil temperature, soil moisture, available plant nutrients and other soil-plant relationships in general. Logically perhaps, these studies have been directed toward an explanation of soil fertility processes defined in terms of chemical composition rather than toward an understanding of the many physical processes and changes constantly going on in soils and to which plants quickly respond.

Nearly a third of a century ago the Michigan Agricultural Experiment Station began a study of soil temperature and soil moisture relationships which has been continued to the present time. The primary objective of this study was a better understanding of the soil mass and how it was affected by changes in temperature and in moisture content, rather than how moisture and temperature conditions and changes may influence soil fertility and plant growth. As the study has progressed, the need for standardized methods for measuring and evaluating the moisture and temperature conditions of soils has become apparent; hence, a number of methods and articles of equipment have been devised in order to facilitate the study of soils and to increase the knowledge of soil properties. Gradually some of these methods have come into extensive use, both in this country and abroad, in industrial plants and agricultural pursuits. Some of the experimental findings incident to this study have become of practical as well as scientific interest and have found many interesting and profitable applications. A few of the findings and applications are discussed briefly in this paper.

Soil Physics and Physical Laws—One of the first discoveries in the course of this study was that the temperature and moisture changes which occur in soils were often not the same as would be expected from the application of the laws of surface tension and viscosity of liquids and the gas laws. The laws operate in the soil but they are often modified by certain features of the soil itself and yield unexpected results. Reasoning from the established laws of physics, for instance, one would assume that as the surface soil cools at night, water is brought to the surface layer in the form of vapor from the warmer soil below and condensed as its temperature is lowered and that some water escapes from the soil in the form of vapor to be condensed as dew. The amount of water moving upward in the soil in this way, however, is negligible. Water that once penetrates to the lower soil strata or horizons is not brought up to the surface again by purely physical

forces and plants must obtain this water from where it has percolated if they obtain it at all. This is one of the reasons why soil management methods that (a) encourage deep root penetration of crops and (b) tend to retain a larger proportion of the rainfall in the surface soil layers are desirable from the standpoint of good crop production.

Measuring the Different Forms of Water in Soils—It has long been known that plants cannot survive when the water content of the soil falls below a certain point. This is not simply a matter of the inability of the plants to extract water from the soil rapidly enough to meet their transpiration requirements, but they cannot obtain any of this water. The soil moisture content beyond or below which plants are unable to obtain water is known as the wilting point or the wilting coefficient of the soil in question. It is low for coarse sandy soils but high for fine clay and muck. The different fractions of soil water have been classified as follows: (a) free or gravitational water, water that moves downward in the soil more or less readily under the influence of gravity, (b) capillary water, which moves very slowly through the soil, either laterally or vertically and which is *available* to plants, and (c) colloiddally adsorbed water, a final fraction held so tenaciously by the soil particles that it does not move in the soil and cannot be utilized by plants. Both the absolute and relative amounts of the different fractions of the total water content vary greatly in different soils and the first two fractions named also vary greatly with soil environmental conditions. Studies at the Michigan Station have led to a much better understanding of the soil moisture-plant relationships and to the development of new and simple methods for quantitatively determining the different soil water fractions.

The old standard method for determining the percentage of unavailable water in a soil, or the wilting coefficient, was to grow seedling corn or wheat plants in weighed quantities of soil under carefully controlled conditions until they wilted. The soil was then weighed, dried in an oven and reweighed and the moisture content calculated. This procedure required weeks. The first of the simplified methods devised by this Station for determining the unavailable, available, and free water in soils was based on the measurement, by means of a dilatometer, of the quantity of water freezing in a soil at different temperatures.

Most of the free water of soils freezes at or above -1.5°C. , most of the capillary water between -1.5°C. and -4.0°C. and the small remaining fraction between -4.0°C. and -78.0°C. ; while the colloiddally adsorbed or combined water does not freeze even when the temperature is lowered below -78.0°C. Determinations on a given soil can be made within a few hours, or even minutes when the apparatus is already set up and several soils are to be tested at one time.

Somewhat later, the so-called alcohol extraction method was devised for determining the total amount of moisture in soils. It is a simple and rapid procedure, suitable for use in the field as well as in the laboratory. In this method a definite quantity of soil is placed in a definite amount of 96-per cent alcohol, stirred, allowed to settle a moment, the liquid filtered off and the density read by means of a hydrometer. By noting the difference between the hydrometer reading

and the reading for the 96-per cent alcohol the percentage of water in the soil sample can be read from a table previously prepared for the purpose. The whole procedure requires only 10 to 15 minutes time. Another equally simple method is to saturate a weighed sample of the moist soil with alcohol, burn the alcohol which will dry out the soil, cool and weigh the dry soil and calculate the percentage of moisture.

More recently, a new method has been devised by means of which periodical or even continuous changes in *available* soil moisture content can be made without disturbing the soil in sampling. Specially constructed, porous blocks made from plaster of paris (gypsum) are embedded in the soil where they may be left for weeks or even years. Suitable wires lead from electrodes placed in the blocks to some convenient point above ground where they can be attached momentarily to the posts of a Wheatstone bridge. A change in soil moisture content causes a proportional change in the moisture content of the gypsum block and a corresponding change in the electrode resistance. When the set-up is properly calibrated, the percentage of available moisture in the soil can be instantly and automatically recorded. This simple and rapid means of determining the available water supply of the soil will greatly aid investigators in their plant and soil studies and provide farmers using irrigation and florists with a means for controlling the water content of their soils, whereby a more economical use of water and labor can be assumed. One large western company now uses thousands of the gypsum blocks in irrigation water control.

The Hydrometer Method of Mechanical Analysis—The terms coarse, fine and very fine as applied to soil texture are in daily use and nearly every one knows what is meant by them. All the particles of a coarse- or of a fine-textured soil, however, are not uniform in size. A coarse-textured soil may contain some fine particles and, conversely, a fine soil may contain some coarse particles. In these cases, however, either the coarse or fine particles predominate. In many soil studies and in many industrial processes involving the use of soils or other finely ground materials it is necessary to know the relative amounts of particles of the various sizes. General mechanical methods of fractionating soils have been in use but they are laborious and expensive to operate. The Soils Section of the Michigan Agricultural Experiment Station has developed a rapid procedure for separating and quantitatively measuring the different soil fractions by means of a special hydrometer, which is also fully as accurate as the older mechanical methods of soil analysis. The method is now known to be in use in more than 3,000 scientific and commercial laboratories throughout the world.

Other Techniques and Applications—In the course of this series of soil moisture and soil temperature studies many other techniques for determining various soil constants and characteristics have been devised and tested. Some of these methods have proved serviceable and they have met wide acceptance in both commercial and scientific laboratories. For instance, a simple, rapid and yet accurate method has been found to determine the moisture equivalent or relative moisture-holding capacity of soils. This method utilizes the force of partial vacuum to pull the water out of the soil, instead of employing centrifugal force

to drive it out as was in common use, which results in a saving of time. Incidentally, the method has shown a close relationship between moisture equivalent and the colloidal content of soils as determined by the hydrometer method which was mentioned above. By accurately determining with a very delicate thermometer the temperature at which soils freeze it has been found possible to determine the salt concentration of the soil solution at different moisture contents, a matter of importance in the so-called alkali injury of plants and in the "burning" of plants due to heavy applications of fertilizers. The method can be used to determine the sap concentration of plants, a matter of much importance in studies of hardness and drought resistance.

All soils when wetted show a certain degree of plasticity or stickiness. Some clays and adobes possess this characteristic to a high degree. It is often important in road building, brick making, in the entire ceramic industry, as well as in agriculture, to have accurate quantitative measurements of the plasticity of soils, clays and other materials. A simple method has been devised, therefore, for measuring plasticity which is finding wide use.

What changes in volume take place when a dry soil is wetted, or when a wet soil dries out? What are the effects on soil granulation of drying and wetting soils at different temperatures? Under what conditions is soil structure comparatively stable? At what soil moisture content does a soil heave most on freezing? What is the influence of soil temperature, particle size and soil granulation on the percolation of water? We need to know the answers to these and other related questions about soils in order to devise the best methods for the control of soil erosion, soil aeration, water supply and conservation, heaving by frost, and to provide the best physical medium for the growth of plants. We have only partially answered most of these questions, but the fund of information about the physical properties of soils is steadily growing as a result of the studies briefly reviewed here.

Almost from the beginning these studies have been in charge of Dr. George J. Bouyoucos of the Soils Section.

V. R. GARDNER, DIRECTOR,
MICHIGAN AGRICULTURAL EXPERIMENT STATION.

LAND-USE PROBLEMS IN CASS COUNTY

K. T. WRIGHT
SECTION OF FARM MANAGEMENT*

Farmers and others interested in agriculture in Cass County recently formed a Land-use Committee for the purpose of (a) studying the problems of proper use of the land, (b) classifying the land in the

*R. V. Baumann of the Bureau of Agricultural Economics, U.S.D.A., assisted in this study in which cooperation was received from F. T. Hady, G. T. Schaefer, and Stanley Herrling of the B.A.E., E. B. Hill of the Section of Farm Management; R. J. Bittner, County Agricultural Agent; and from many farmers, county officials, bankers, and other people in Cass County.

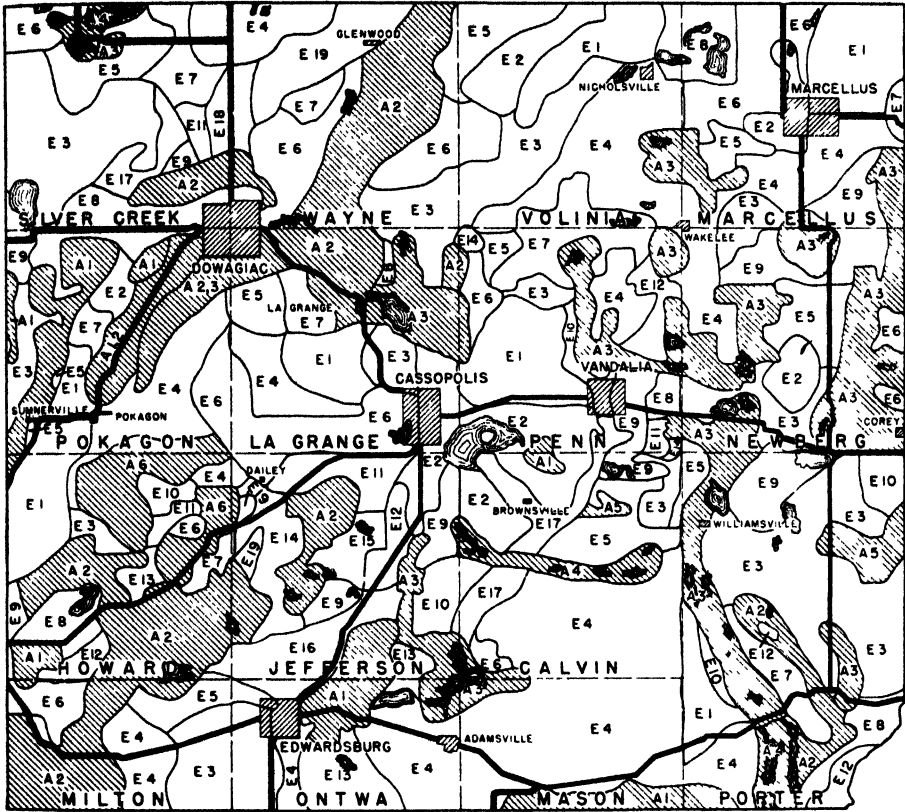


Fig. 1. Cass County Land-Use Areas as designated by the County Land-Use Committee, showing the areas adapted to farming (E-1 etc.) and those better adapted to recreation, reforestation or game refuges (A-1 etc.).

county according to the use to which it was best suited, and (c) the making of recommendations for a land-use program for the county.* The committee considered the problems of soil maintenance and improvement, size and organization of the farms, farm income, tenancy, sales of farms, tax delinquency, and many others.

Recommendations for the land suited to permanent agriculture, dealt with the size of the farm, the percentage of the farm that should be devoted to the various kinds of crops, and the kind and amount of livestock that should be kept. The committee realized, even as their recommendations were being made, that further study might well be given the problems and recommendations. This farm management study is the result of their request for further work on their land-use problems.

*The land-use project in Cass County was conducted cooperatively through the Cass County Land-use Committee, the State Land-use Committee, Michigan State College, and the Bureau of Agricultural Economics of the United States Department of Agriculture.

Size of Farms

Many persons talk about the trend in the size of farms, and the need for either more small or large farms, depending upon their point of view. One of the first things considered, therefore, was the trend in the average size of the farms in this county, and the number of farms of the different sizes. During the 40 years from 1900 to 1940 the average size of farms decreased from 118 to 108 acres.

The total number of farms in the county decreased from 2,609 to 2,466, or a decrease of 5 per cent. The number of farms of less than 50 acres, however, increased both in actual number and in percentage of the total, being 21 per cent of all farms in 1900 and 27 per cent in 1940. The number of farms of 100-174 acres decreased during this time, while those of other sizes made up about the same percentage of the total in 1940 as in 1900.

Much is also said about the farms on good land being relatively small, and those on poor land being large. A survey of approximately 20 farms in each of five selected land-use areas ranging from the best to the poorest land, showed the farms in the E-1 areas (the best land) to be 190 acres in size compared with 138 acres in the A areas (the poorest land) (see Table 1). The acres in crops per farm were 105 and 58, respectively. Thus, it seems that contrary to popular opinion, the farms on the good land in this county at least were larger than those on poor land.

Crop Acreage and Production

Some ask if there have been any long-time trends in the kind of crops grown in the county, or any trends in the crop yields. United States Census reports show that the acreage devoted to corn in 1939 was about the same as that 40 years earlier. The total acreage of hay likewise was about the same, but the land in alfalfa hay increased from 8 acres to 20,000 during this period. The big change in kind of crops grown in Cass County has been the reduction of wheat acreage to one-fourth of what it was 40 years ago.

How much have the crop yields declined? Data were obtained from the State Statistician on Cass County yields from 1911 to 1940. To study the crop yield trend, the yields of corn, oats, wheat and hay were combined and weighted on the basis of their acreage in 1935. The average for the 30 years was considered as 100. Yields for the first 15 years averaged 95, while those of the last 15 years averaged 105. In other words, crop yields during the past 15 years were some 10 per cent higher than in the 15 years immediately preceding.

The important thing that developed in this study of 30 years of crop yields was the great variation in yields from year to year, ranging from 60 per cent of the 30-year average in some years to as high as 130 per cent of that average in other years. These wide variations in yields in the county from one year to another reduce the amount of livestock kept on the farms, inasmuch as farmers tend to keep the amount that they can feed in the low-yield year. This in turn reduces the farm income.

The crop yields on the land designated as sub-area E-1 were 120 per cent of the county average, while the yields in the poorest sub-areas

Table 1. Organization of farms in the survey, by sub-areas, Cass County, 1940

Item	E-1	E-4	E-6	E-9	A
Number of farms	26	22	19	15	15
CROP ACRES PER FARM					
Corn	28	21	26	18	18
Oats	18	8	8	7	4
Wheat	25	16	11	11	6
Spelt	2	3	3	2	3
Alfalfa hay	17	15	11	10	17
Other hay	10	9	6	7	4
Other crops	3	2	2	2	5
Tillable idle land	3	14	10	10	10
Tillable pasture	36	22	20	19	20
Non-tillable pasture	12	31	27	12	29
Woods, farmstead and roads	36	39	18	34	22
Total	190	180	142	132	138
LIVESTOCK NUMBERS					
Cows	9	7	8	5	5
Sows	6	4	3	3	3
Ewes	13	8	6	7	9
Hens	98	79	64	102	78
LABOR AND POWER					
Days productive work	411	298	298	253	240
Men (average number)	1.8	1.5	1.5	1.4	1.2
Horses (average number)	3.2	3.7	2.9	2.6	2.5
Tractors (percent having)	62	24	47	33	20
Value of farm per acre	\$56	\$41	\$46	\$40	\$28

were only 77 per cent of the average, according to the survey of 97 farms in five sub-areas. In other words, crop yields on the best land were some 50 per cent higher than on the poorest. The total crop production per farm in the E-1 sub-areas was approximately 2.5 times that per farm in the A or non-agricultural areas, owing to the higher yields and to the 1.8 times larger acreage of crops per farm.

Livestock Numbers and Production

In regard to the number of livestock in the county, there were approximately one-fifth as many sheep in Cass County in 1940 as in 1900; one-half as many horses, two-thirds as many hogs, the same number of chickens, and 35 per cent more milk cows. It was found in this study that the farmers in the poorer areas kept about the same amount of livestock for each 10 acres of crops as did the farmers on the best land, but because the latter group had larger farms they had more livestock per farm. Because the crop yields were lower on the poorer land, there was less feed per unit of livestock inasmuch as the same amount was kept for each 10 acres as on the more productive land.

The production of milk and butterfat per cow, and the production of the other livestock were less on the poorer land than on the more productive land. The combined production index of the livestock in the A areas was 86 per cent of the average of the entire group compared with 115 per cent of average in the E-1 areas. That is to say, livestock rates of production tended to correspond to the crop yields. The livestock in the areas of less productive land either was (a) fed less feed, (b) of poorer quality, or (c) received poorer management on the part of their owners, or a combination of all those factors.

The total production of livestock products per farm in the E-1 areas was about two and one-half times as great as in the A areas, as a result of the higher rates of production and the larger number of livestock units per farm. Since the bulk of the farm receipts in this county are from the sale of livestock products, the gross income per farm would be in about the same proportion as the production of livestock products.

Farm Practices

In connection with the livestock rates of production, it was found that more than one-half of the men in the Dairy Herd Improvement Association in the county were in the three best land areas, E-1, E-2 and E-3, which comprise approximately one-fourth of the county. In other words, there were twice as many of the D.H.I.A. men in these areas as would be expected on the basis of the acreage involved. Similarly the number of men keeping farm account books and the number of 4-H club members were twice as great as would be expected. That is to say, approximately one-half of the men, or boys and girls, in those three activities were located on the three best land areas, which comprise only one-fourth of the county. Thus, many farm people on the poorer lands are not participating in some of the activities that would improve their farming practices, and result in higher crop yields and livestock production.

Farm Tenancy

Some general factors and conditions relating to agriculture were also considered in this study. One of these concerned tenancy. About 22 per cent of the farmers in Cass County were tenants in 1940. This is virtually the same percentage as in 1900. While tenancy does not seem to be increasing in this county, it was found that the tenants do not stay on one farm very long. According to the 1935 Census almost one-half of the tenants had been on their present farms less than two years. Long-term leases are needed to encourage the maintenance of the soil and the farm buildings. It was also found in this study that there was a better chance of the soil's being maintained when the landlord was a local person.

Farm Loans

The condition of farm loans in the various land-use areas was also considered. It was found that the farm loans were paid less promptly and more than twice as many were delinquent in sub-areas E-13 to A, the poorest land, than in the areas E-1 to E-3. Farmers in the poorer land areas experienced more difficulty in repaying their loans. It would seem that farmers in these areas should borrow only in small amounts, as seldom as possible, only for productive purposes, and attempt to obtain a flexible repayment plan.

Tax Delinquency

The 1938 taxes on 15 per cent of the farms in the county had not been paid by Nov. 1, 1940. These tax-delinquent farms averaged 50 acres in size or slightly less than one-half the average size of all farms in

the county. It was also found that more than twice as much land was delinquent in the A areas than in the E-1 to E-3 areas, even though the areas were the same size, and also despite a 40-per cent lower tax rate per acre.

School Costs

Some 13 per cent of the rural schools had an average daily attendance of less than eight pupils and the cost of educating each pupil in these schools was more than twice as much as the county average of \$66 per pupil. Some of the districts could be combined, which would either provide better educational facilities for the pupils, or reduce the cost per pupil, or both.

BONING POULTRY

J. A. DAVIDSON, P. J. SCHAIBLE AND RAY PILLAR
SECTIONS OF POULTRY HUSBANDRY AND CHEMISTRY

Boning has not been practiced to any great extent in the poultry industry, probably because labor costs and shrinkage necessitate a higher price per pound. Nevertheless, boned poultry does possess certain definite advantages. For example, it can be merchandised as a packaged food, thus reducing the higher cost of special skill required behind the counter. In the frozen food locker industry and in cold storage in general, much valuable storage space would be conserved. By-products of boning, now wasted, would be concentrated at points where they could be salvaged to help pay for operating costs. Boned

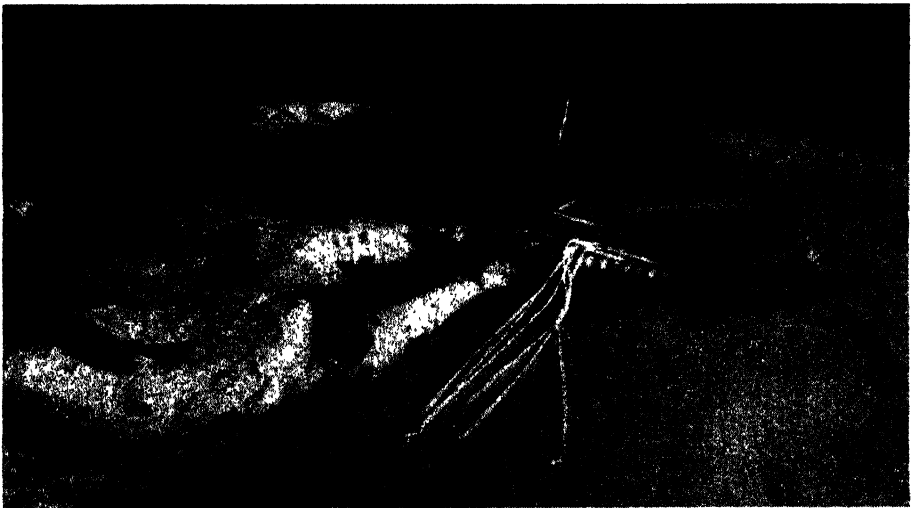


Fig. 1. Removal of tendons.



Fig. 2. Removing neck.



Fig. 3. Sawing through back bone.

poultry is more easily served by chefs because the meat may be mechanically sliced, either hot or cold, and provides consumers with a ready-to-cook product and more uniform servings of light and dark meat.

A brief summary of three general procedures for boning poultry has been reported by Schaible and Davidson.¹ The method used by Davidson, Schaible and Pillar,² in an experiment on curing, smoking and cooking turkey meat is suitable for the small producer or anyone occasionally wishing to bone a bird, and is therefore, described and

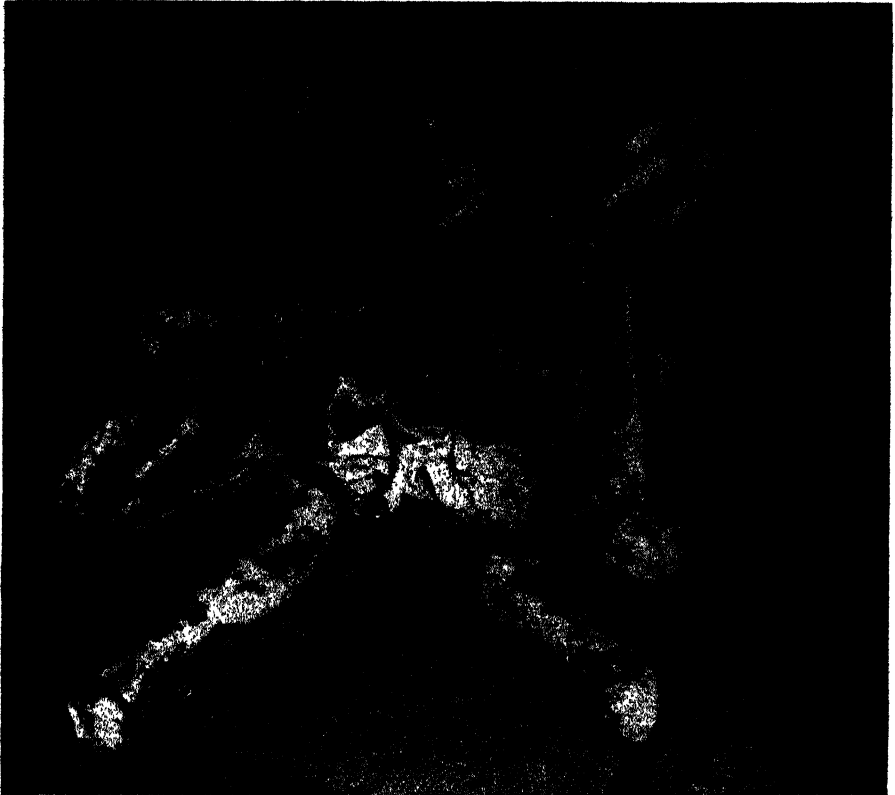


Fig. 4. Removal of back and ribs.

illustrated more completely in this article. The purpose of any procedure is to remove the flesh from the skeleton as rapidly and completely as possible. Speed and thoroughness depend upon practice and familiarity with the anatomy of the fowl. The turkey was used as a model in the following illustrations.

¹Schaible, P. J. and Davidson, J. A. Boning, Curing and Smoking Poultry Meat. *The Egg and Poultry Magazine*, April 1941.

²Davidson, J. A. Schaible, P. J. and Pillar, Ray. *Mich. Agr. Exp. Sta. Quart. Bull.* 23 (4), May 1941.



Fig. 5. Wing bones removed and flesh being eased from breast bone.

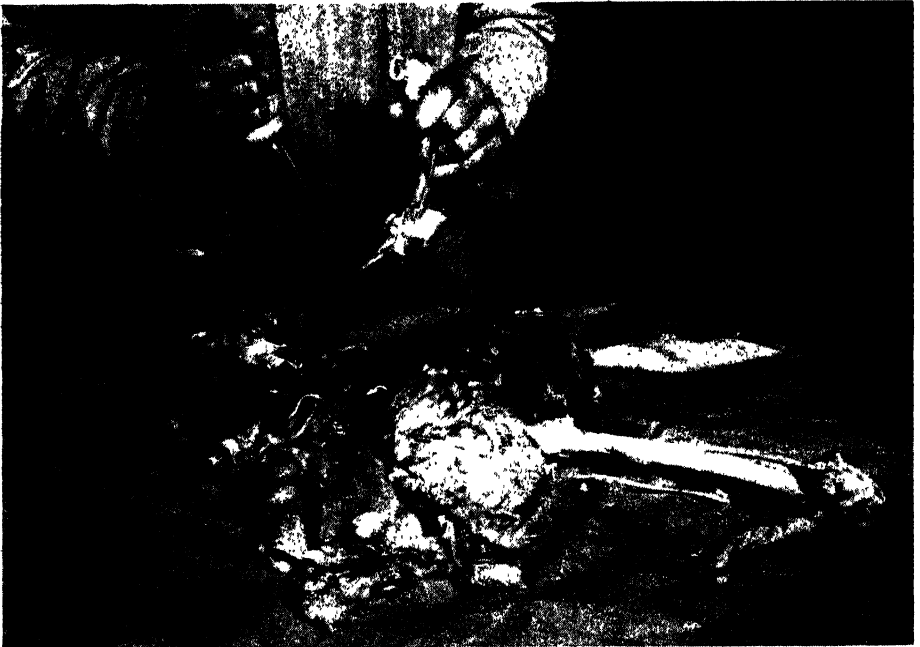


Fig. 6. Removing leg bones.

Killing and Chilling

Only healthy, well-fleshed birds should be slaughtered, and they should be starved from 8 to 10 hours. Hang the bird up by the feet to insure proper bleeding and to prevent bruising of the flesh. Cut the blood vessels far back in the throat with a "sticking" knife applied through the mouth or simply cut the throat of the bird. If the bird is to be dry-picked, in addition to cutting the blood vessels in the throat, it should be "stuck" in the brain either through the cleft in



Fig. 7. Bones removed from carcass.

the roof of the mouth or just back of the eye (after profuse bleeding occurs). Remove the feathers by dry-picking or the semi-scald method. In the latter case care should be exercised so that partial cooking of the skin does not occur.

Cool the carcass in the refrigerator. If refrigeration is not available chill in cold or ice water. Twelve to twenty-four hours chilling is usually required.

Drawing

Drawing is not essential for boning but it simplifies the procedure for the beginner. Remove the head, and slit the skin along the back

of the neck and push it away from the neck. Remove the crop and "windpipe". With the bird lying on its back, slit the skin from the point of the keel bone to and around the vent. Reach forward and around the heart, liver and gizzard with the fore and middle fingers and draw the viscera out of the body cavity.



Fig. 8. The boned carcass.

Removal of Tendons

The tendons in the legs should be removed, especially those of turkeys. There are several different types of commercial "tendon-pullers". However, removal of the tendons may be accomplished simply by using an ordinary hook rigidly secured. Slit the skin along the side of the shank and expose the tendons, being careful not to cut the latter. Place the tendons over the hook and, grasping the upper part of the leg, pull steadily or twist slowly. If jerked, the tendons will break before complete removal. Figure 1 shows one leg with the tendons removed and the other with the hook in place ready for pulling. After the tendons have been removed, cut off the shanks and feet at the hock joint and the tips of the wings.



Fig. 9. Folding breast over dark meat.



Fig. 10. Method of making a double roll the left half completed.



Fig. 11. Completed double roll—bottom view.

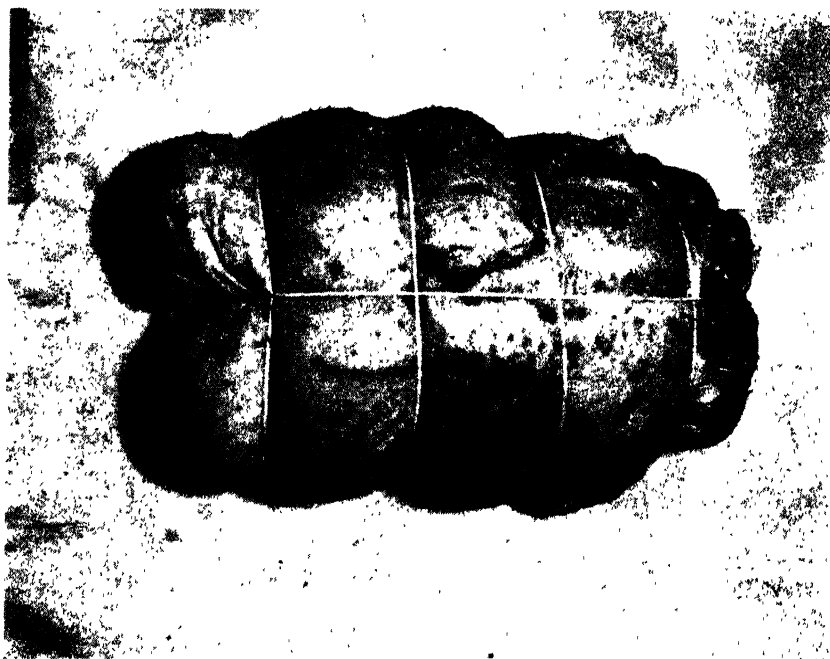


Fig. 12. Completed double roll—top view.

Boning Procedure

Remove the neck by disjointing and cutting next to the body (Fig. 2). Cut through the back with a saw (Fig. 3). On some birds smaller than the turkey, this may be done with either game shears or a heavy knife.

Disjoint wings and legs from the body by pulling away from their normal position on the body. Remove back bone and attached ribs as illustrated in Fig. 4. Push the flesh away from the breast bone with the fingers or knife, if necessary (Fig. 5). A thin-bladed or boning knife is helpful.

Remove bones of the legs and wings by grasping the end that was nearest the body and ease off the flesh by pushing and cutting. Remove any remaining tendons. The removal of the leg bones is shown in Fig. 6. Figure 7 shows the bones that have been removed from the carcass. The bones with a small amount of attached flesh together with the giblets may be salvaged for making soup.

Rolling the Boned Carcass

The boned carcass with the skin side down is shown in Fig. 8. Flatten out the flesh from the legs and wings and rearrange the light and dark meat and fat so that uniformity may be attained.

If the carcass is to be used immediately, dressing may be included with the roll. The illustrations show the preparation of a double roll without the inclusion of dressing. There are a number of ways for rolling but the use of a double roll is simple and gives a good distribution of light and dark meat.

Fold the breast portion over the dark meat (Fig. 9), and roll from right and left toward the center as shown in Fig. 10. Hold in place with skewers or knives stuck in a heavy wood plank or table and tie with cord (Fig. 11). Figure 12 shows the top of the double roll after tying.

The roll is now ready to be cooked or placed in a frozen food locker. The usual procedure of wrapping in moisture-proof covering, prior to quick freezing should be observed.

THE INFLUENCE OF RANCIDITY IN MILK UPON THE ACCURACY OF THE FAT DETERMINATION BY THE MOJONNIER METHOD

L. A. GOULD
SECTION OF DAIRYING

Although the ether extraction (Mojonnier) method for determining the fat content of milk is accepted as being highly accurate, there exists the possibility that certain changes which may occur in the milk may affect the accuracy of the test. One such change which deserves consideration in this connection is the development of rancidity and the corresponding formation of free fatty acids.

Several workers have reported that rancidity development may result in errors in the ether extraction technique. In a study of methods of analyzing butter, Bird and Breazeale (1) found the Mojonnier results were often low; the extent being directly in relation to the free fatty acids in the butter. The errors were as great as 3 to 4 per cent in cases where the titratable acidity of the butter was high. These workers attributed the decreased values to the formation of ammonium salts which were more soluble in the water layer than in the solvents.

Limited information is available relative to the influence of rancidity on the Mojonnier test of milk. However, Holland (3) observed that composite samples of raw milk showed progressive decreases in fat over a period of 14 days when analyzed by the Mojonnier technique, whereas pasteurized composite samples showed no such decrease. The total decrease after 14 days amounted to 0.3 per cent, which was attributed to the results of lipase activity. Starr and Herrington (4) found that when fatty acids were added to butter oil, a portion and a rather constant fraction of the free fatty acids were recovered by the Mojonnier test, but a larger portion was lost in the ammoniacal layer. These workers concluded that "since the quantity of free fatty acid in an actual sample is usually not known, and varies depending on the degree and quality of rancidity (lipolysis), the Mojonnier fat test on rancid samples will be decreased by a variable, unpredictable quantity."

No direct evidence has been presented which shows the extent to which the Mojonnier test of milk is affected by specific changes in the titratable acidity of the fat. Information dealing with this pertinent point is herewith presented.

Experimental Procedure.

To activate lipase activity and produce quickly a high degree of lipolysis, raw milk was warmed to about 100° F. and was homogenized at approximately 500 pounds pressure. The milk was thoroughly mixed before homogenization, and a portion of the milk was removed and pasteurized. This portion served as the control lot. The remainder of the milk, following homogenization, was divided into three lots. One lot was pasteurized immediately following homogenization, one pasteurized after 24 hours of storage, and the last portion pasteurized after 48 hours of storage. Pasteurization was at 148-150° F. for 30 minutes and was conducted in containers fitted with covers to prevent excessive evaporation. At the close of the pasteurization, a sample for fat determination was removed from each lot, placed in a closed container, and immediately cooled. The remainder of the milk was separated, the cream churned, and the butter oil obtained by melting, centrifuging, and filtering the butter.

The titratable acidity of the fat was determined by the method used in previous work (2), and the values expressed as acid degrees (ml. of 1/N NaOH per 100 grams fat). Mojonnier determinations on weighed samples of the milk were conducted according to directions (5). Care was used to control and unify all steps in the testing operation.

Experimental Results

Six series were conducted, and the results are presented in Tables 1 and 2. In Table 1 is shown the change in the fat test of the milk.

Table 1. The Mojonnier fat test of milk at different levels of rancidity.*

Series	Lot Number							
	1		2		3		4	
	a	b	a	b	a	b	a	b
	%	%	%	%	%	%	%	%
1.....	4.9868	4.9793	4.9410	4.9674	4.9083	4.9124	4.8165	4.8379
2.....	3.5608	3.5811	3.5803	3.5890	3.5345	3.5264	3.4486	3.4649
3.....	5.1028	5.1209	5.0969	5.1023	5.0154	5.0280	5.0104	5.0180
4.....	4.1531	4.1442	4.1389	4.1471	4.1036	4.1073	4.0718	4.0889
5.....	2.9948	3.0140	2.9495	2.9527	2.9230	2.9372	2.9130	2.9250
6.....	4.6752	4.6938	4.6381	4.6451	4.5193	4.5418	4.5600	4.5460
Average....	4.2456	4.2555	4.2241	4.2339	4.1673	4.1755	4.1367	4.1701
Total Average	4.2505		4.2290		4.1714		4.1534	

*—Lot 1—Control.

Lot 2—Homogenized 500 lb., pasteurized immediately

Lot 3—Homogenized 500 lb., pasteurized after 24 hours

Lot 4—Homogenized 500 lb., pasteurized after 48 hours

Data for duplicate determinations are presented to show the uniformity of the results. For example, the maximum variation between duplicate determinations was 0.0264, and only in four cases did the variation reach or exceed 0.02 per cent. The average variation between duplicate determinations was 0.0127.

The results in Table 1 show a slight but definite trend toward a decrease in the fat test in the milk as the milk is homogenized and then stored. The milk immediately pasteurized following homogenization varied only slightly from the control, the difference being only 0.0215 per cent. After 24 hours of storage, however, the raw homogenized milk had an average fat test of 0.0791 per cent less than the control, whereas the 48-hour sample averaged 0.0971 per cent less.

As expected, all of the homogenized milk underwent lipolysis rapidly. At the 24- and 48-hour periods, the milk had a pronounced rancid

Table 2. Fat acidities in milk, samples analyzed by the Mojonnier method.¹

Series	Lot Number			
	1	2	3	4
1.....	0.33	2.45	5.33	6.28
2.....	0.50	2.45	5.45	5.95
3.....	0.65	2.23	7.23	7.85
4.....	0.92	2.35	7.12	7.48
5.....	0.90	1.13	6.78	7.80
6.....	0.85	2.45	6.87	7.38
Average	0.691	2.68	6.16	7.12

*—Values in acid degrees (The ml. 1/N NaOH per 100 grams fat.)

odor and taste. Furthermore, the fat acidity values for all of the homogenized milk were considerably above those for the control samples. These values are presented in Table 2.

The data in Table 2 show the extent to which the fat acidities increased. Homogenization alone increased the values approximately 4-fold, whereas the values had increased approximately 9-fold after 24 hours and more than 10-fold after 48 hours.

Summary and Conclusions

Six series of analysis were made for fat and for fat acidity on normal milk and on milk made rancid by homogenization. The results show that although fat splitting occurred to a great extent, the Mojonnier results were not greatly invalidated. Increases in the fat acidity of approximately 10-fold caused a reduction in the Mojonnier fat test of the milk of only 0.0971 per cent. The extent of lipolysis obtained in this study is considerably greater than would be found usually in rancid milk, owing to the activating effect of homogenization. Consequently, the influence on the Mojonnier results would be greater.

Larger errors in the Mojonnier results would be expected to occur in rancid products high in fat because more fat would be subjected to the action of the Mojonnier reagents. Thus, in butter, where the fat content is approximately 80 per cent an appreciable amount of lipolysis would likely cause a pronounced error in the results by the ether extraction procedure.

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SURVEY OF FARMERS' LOAN ACCOUNTS AT MICHIGAN COUNTRY BANKS

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With the federal government's food defense program encouraging an expansion in the production of meat animals and of dairy and poultry products, and with rising farm labor costs tending to induce increasing purchases of labor-saving equipment, Michigan farmers are showing a disposition to make greater use of bank credit than has been the case generally during the last 10 years. Under those conditions it seems timely and appropriate to present some of the findings of a survey made by the Economics Section of the experience record of selected Michigan country banks with short-term loans* made to farm customers during the decade 1928-37.

Nature and Method of the Survey**

This study, carried out by Dr. R. J. Burroughs with the cooperation of the Michigan Bankers' Association, was based on an examination of the ledger accounts of 100 sample farm borrowers at each of nine rural banks located in the following counties selected to represent different types of farming areas in the state.

COUNTIES IN WHICH BANKS LOCATED	PREVAILING TYPE OF FARMING
Jackson, Ionia	General farming
Lenawee	Cattle feeding
Berrien, Oceana	Fruit growing
Ottawa	Dairy and poultry
Saginaw	Beans and general farming
Huron	Livestock, feed grains, and hay
Wexford	Potatoes, dairy and livestock

From the records of the cooperating banks the investigator was able to construct loan histories (notes signed, repayments, and balances owed at various dates) for each of the 900 sample farm customers for the period from Jan. 1, 1928 to various terminal dates in 1936 and 1937. This approximate decade, it will be recognized, covers the span of a well-defined economic cycle—embracing the "prosperity" years of 1928-29, the phase of "depression" and falling prices between 1930 and 1933, culminating in the "Bank Holiday" of February-March

*Loans secured by mortgages on farm real estate were not included in this study.

**A detailed report of this survey is contained in the forthcoming Special Bulletin 311 of the Michigan Agricultural Experiment Station, "Experiences of Michigan Country Banks in Short-term Loans to Farmers," by R. J. Burroughs, in collaboration with H. S. Patton.

1933,* and the phase of fitful "recovery" and improving farm prices from mid-1933 to 1936-37. The survey thus presents an intensive sampling of farmer-banker relations both in different farming areas of the state and under different general economic conditions.

As a supplement to the information obtained from the loan records of the cooperating banks, a questionnaire regarding the use to which individual loans were applied was mailed to the sample customers through officers of seven of the banks.** This additional information was supplied by 340 borrowers with respect to a total of 2,283 separate loans.

Inquiries Included in the Study

Some of the questions on which information was sought in this survey were as follows:

(1) To what extent does the use of bank credit by farmers vary from season to season within the year, and from year to year within the economic cycle?

(2) For what amounts are bank loans most frequently made to Michigan farm borrowers, and how do these vary with different types of farm enterprise?

(3) What are the most frequent purposes for which farmers borrow from their banks, and in what proportions are loans distributed on this basis?

(4) How "liquid" are bank loans to farmers as measured by: (a) the proportion of loans which are paid at note maturity dates; and (b) the length of time loans remain outstanding?

(5) What relationships are to be found between "liquidity" of bank loans to farmers and such factors as: (a) the purposes to which loan proceeds are applied by borrowers; (b) the size of loans; and (c) the period in the economic cycle when loans originated?

(6) Are loans by country banks to farmers less liquid and accompanied by greater proportionate losses than loans to non-farm customers?

Some of the findings of this survey in respect to these questions are briefly presented in the following paragraphs. Inasmuch as the data are derived from a rather limited sample, they do not afford a basis for broad generalization, and should be interpreted with caution. In view, however, of the manner in which the sample was constructed the findings may be regarded as reasonably representative of banker-farmer short-term credit experience in Michigan. Farm readers of this report may find it of interest to compare their own individual records with the group-sample records obtained from this survey.

Seasonal Variations in Farm Borrowing

On the basis of the loan accounts of "continuous borrowers" (i.e. of farmers who appeared on the banks' books as borrowers both at the beginning and at the close of the survey period) the following index

*Five of the nine banks included in the survey were permitted to reopen following the "Bank Holiday" only after going through some form of reorganization, involving the transfer of their more doubtful assets to depositors' liquidating corporations or to segregated trust accounts. For these banks the "sample" includes proportionately farm customers owing money to both the new banking corporation and to the liquidating corporation.

**The Berrien and Ottawa county banks did not participate in this phase of the survey.

numbers were obtained of (a) the average number of new loans made during each quarter year, and (b) the average amount owed to the banks by their borrowers at each quarter-ending.

QUARTER ENDING	INDEX OF NEW LOANS	INDEX OF BALANCES OWED
March 31	107	102
June 30	109	97
September 30	83	97
December 31	101	104

It seems from the foregoing that Michigan farmers in general borrow from banks more frequently in the first half of the year, and to a lesser extent during the third quarter when cash income from crops is mainly concentrated. The seasonal pattern of bank borrowings showed considerable variation, however, among the individual banks, reflecting the characteristic type of farming conducted by their customers. Thus quarterly variations in new loans were much less marked among customers of the Ionia bank serving a general farming and dairying constituency than in the case of the Berrien County bank operating in the fruit belt. While spring planting appears to be associated with a first quarter peak of new loans by the banks in Jackson and Saginaw counties, fall purchases of feeder cattle are reflected in a fourth quarter peak in the case of the Lenawee County bank.

Although the distribution of new loans shows marked seasonal fluctuations of varying patterns, the amounts owed to banks by continuous customers showed surprisingly little variation from quarter to quarter, except in the cases of the Lenawee and Berrien banks whose farm loans are made mainly to livestock producers and fruit growers, respectively. The inference would seem to be that as old loans are repaid or reduced most farmers with established lines of credit at their banks shortly find occasion to borrow for other purposes, so that on the average their dollar obligations to the bank remain fairly constant from season to season. This appears to be more commonly the case in general farming areas, where the succession of diversified operations tends to stabilize the needs for credit throughout the year. The evidence also suggests that many farmers depend more or less continuously on their bank to furnish part of their operating capital.*

Cyclical Variations in Bank Credit to Farmers

While the volume of bank credit outstanding to farm customers showed only slight variations within any given year, wide fluctuations were found to occur in the aggregate balances owed by continuous borrowers at corresponding dates in the different years included in the survey period, as indicated by the following indexes.**

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
June 30	116	121	132	120	106	92	76	69	83	82
December 1	136	124	116	106	98	83	69	78	77	89

*The investigator concluded that probably more than half of the sample borrowers were in this position.

**These index figures were adjusted for seasonal variation.

"Balances owed" at given dates are a combined reflection of the number and size of new loans made by banks and of outstanding balances on old loans. Both of these elements are greatly affected by cyclical fluctuation in farm prices, costs and incomes, in general business conditions, and in the psychological attitude of both farmers and bankers. The volume of new farm loans in a given period depends, on the one hand, on the demand for credit by farmers for expanding production and consumption, making improvements and adding to their equipment in good times, and for meeting pressing obligations to other creditors in hard times. On the other hand, it depends on the willingness of banks to extend new credits, as governed by their lending resources and their judgment of credit risks. Again the extent to which old loans are liquidated depends both on the capacity of farm debtors to repay or their willingness to economize, and on the disposition of bankers to force liquidation and deny renewals of notes.

As shown by the above-mentioned indexes of balances owed, borrowing was at a relatively high level during 1928 and 1929 when both Michigan farm prices and costs were about 70 per cent above the 1910-14 average.* Doubtless some of this borrowing was induced by high farm wages and taxes, while the relatively high level of farm prices may have encouraged borrowing for purchases of automobiles and other durable goods. Although farm prices started to decline at the end of 1929, no appreciable reduction in borrowers' balances occurred until the last quarter of 1931. This apparently reflected difficulty in meeting maturing loans and some new borrowing to pay off other obligations in the expectation that farm prices would recover. When instead of this, prices continued to decline still more abruptly during 1932 and early 1933, bank balances were reduced to some extent through forced liquidations, while new loans were generally refused by bankers in the face of shrinking assets and mounting cash withdrawals.

It will be seen that borrowers' obligations to the banks reach their lowest level in the last half of 1934 and the first half of 1935. Since the upturn in farm prices commenced in the spring of 1933—under the influence of government reflationary measures and the launching of the Agricultural Adjustment program—it would appear that farmers were applying their improved incomes to reducing their indebtedness to the banks, doubtless under pressure from the latter. The relatively slight increase in new bank borrowings (as reflected in balances owed) during 1936 and 1937 when the farm purchasing power index rose well above the 1928-29 level, may be attributed largely to caution on the part of both farmers and bankers, mindful of mutually distressing credit experiences during the depression years.

*The average annual indexes of the prices of Michigan farm products and of farm costs for the years included in the survey were as follows (1910-14 = 100):

Year	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Index of farm prices..	166	167	138	95	65	75	94	107	124	132
Index of farm costs...	170	171	160	138	114	103	111	111	113	122
Ratio of farm prices to costs	98	97	90	68	56	71	80	94	106	108

Size and Purpose of Loans

One of the rather surprising revelations of this survey was the relatively small size of the bulk of loans made by the country banks to their farm customers. Out of 2,869 loans which were analyzed, more than half were for sums of less than \$100, and one out of every eight were for amounts less than \$25. In only 3.6 per cent of the cases did the size of the loan exceed \$1,000.* It was observed that the highest proportion of small size loans were made by the banks in Ionia, Huron and Jackson counties serving general farming areas where income is more evenly distributed throughout the year.** Larger size loans were more common in the case of the Lenawee County bank which does a considerable business in feeder cattle loans, and of the Oceana County bank which is called on to meet the seasonal credit requirements of specialized fruit farmers.

The principal determinant of the size of individual bank loans to farmers appears to lie in the purposes for which the funds are borrowed, which is influenced in turn by the type of farming conducted by the borrower. Of 2,727 loans where the use of the proceeds was indicated by borrowers, 88 per cent were applied to production purposes and 12 per cent were used wholly or partly for family consumption purposes. In the accompanying table, column A shows the number of loans for each indicated purpose. Entries in column B mean that approximately three-quarters of the loans for the itemized purpose were made for individual amounts below the dollar figures shown.

Purpose of Loan	A. Number of cases	B. Approx. 75% of loan cases for amounts under
PRODUCTION LOANS....	2405	\$175
Livestock purchase.....	657	325
Labor and machine hire.....	262	125
Seed and fertilizer.....	221	100
Machinery purchase.....	182	125
Stock feed.....	120	100
Taxes.....	81	175
Truck or tractor purchase.....	78	400
Buildings.....	66	175
Interest.....	65	150
Insurance.....	63	50
Land purchase.....	61	700
Spray material.....	29	125
Nursery stock.....	5	75
Combination purposes.....	190	125
Miscellaneous.....	325	300
CONSUMPTION LOANS.....	281	150
Living expenses.....	114	50
Automobile.....	92	350
Household furnishings.....	39	125
Medical, hospital, funeral.....	39	125
MIXED PRODUCTION AND CONSUMPTION.....	38	225

*As previously stated, farm real estate mortgage loans were excluded in this survey.

**Growers of grain, beans, and potatoes commonly obtain advances on stored produce from the elevators or warehouses in which they are held, without directly resorting themselves to banks.

As would be expected, the bulk of larger size loans are shown to be made for the purchase of livestock and for such fixed capital purposes as financing purchase of land,* trucks, tractors and automobiles, and construction or improvement of buildings. Both the number and size of loans for meeting tax and interest payments are significant for the period covered in the survey. The very substantial reductions in farm real estate tax levies in Michigan since 1933,** and the extensive refinancing of farm mortgage debts through federal agencies, have presumably resulted in considerably smaller bank borrowings by Michigan farmers for meeting such obligations in recent years.

How "Liquid" are Bank Loans to Farmers?

Liquidity of loans to farmers, from the standpoint of the banker, is a matter of the time and manner in which the borrowers' notes can be converted into cash, preferably through payment at maturity dates, or alternatively through collection pressure or sale of the security pledged, or through rediscounting the borrowers' paper at some other bank. From the standpoint of the farm borrower, liquidity is essentially a matter of using the loan proceeds in such productive forms as will contribute to future cash returns that will permit repayment of loan obligations as they become due. In this study the degree of liquidity of bank loans to farmer customers was measured by the number of months loans remained outstanding, and also by the number of renewal notes involved before a loan was completely discharged.

Out of 2,283 separate loans for which complete loan histories were obtained, it was found that 14 per cent were repaid within one month, 40.6 per cent within 3 months, 66.3 per cent within 6 months, and 86.7 per cent within periods of less than one year. Considering the extremely difficult conditions confronting Michigan farmers in most of the years included in the survey period, this may be regarded as a distinctly creditable record. It is to be noted, however, that while approximately six-sevenths of these loans were repaid in less than a year, the remaining one-seventh had to be carried by the banks for very extended periods. In 145 cases from two to as many as seven years elapsed before the loans were finally liquidated.

From the bankers' standpoint liquidity is most satisfactorily realized when loans are repaid in full at note maturity dates. Out of 2,869 cases examined, two-thirds of the notes were drawn for periods of from one to four months, and only 7 per cent had maturities of more than seven months. Among 2,283 loan history cases, 60 per cent of the original notes were paid at maturity dates. In the 906 instances where renewals were involved, nearly three-fifths were renewed more than once, the number of successive renewals running up to as high as thirty. In the majority of these cases some payment on account was made at the maturity date and a new note signed for the balance.

The fact that with two out of every five of these loans, one or several renewals were required, may be interpreted as indicative of the

*Virtually all the loans under this classification represent temporary financing of land purchases in anticipation of permanent financing from other sources, or small advances supplementing mortgage loans.

**See Mich. Agr. Exp. Sta. Spec. Bull. 300, "Michigan Tax Trends as Related to Agriculture," by D. C. Cline.

financial difficulties of farm borrowers during most of the survey period. But, in view of the further fact that all these loans were eventually paid off, it also suggests that the periods for which bankers generally preferred to have notes drawn were frequently considerably shorter than the natural self-liquidating period of the operation financed by the loan.

As a check on the farm credit experience of the nine banks co-operating in the survey, questionnaires were mailed through the Michigan Bankers' Association in the summer of 1937 to 380 rural banks throughout the state, of which 110 made returns. Sixty per cent of the latter reported that more than half of all their customer loans were ordinarily made to farmers. To the question: "Do merchants need or get renewals as often as farmers?" three out of five giving definite replies on this point answered "yes." To the query: "In proportion to amounts loaned have you lost least to farmers, merchants, or manufacturers?" about the same proportion indicated that their losses had been least on loans to farm customers.

The evidence gathered from this study seemed to indicate therefore that while a small proportion of bank loans to Michigan farmers*—apparently approximately 15 per cent—are decidedly "slow" accounts, very few outright losses on farm loans have been experienced by country banks, and that on the whole Michigan farm borrowers have proved to be at least as good credit risks as small town merchants and manufacturers.

Factors Related to Liquidity of Farm Loans

Special attention was given in this study to examining what relationship might be found between liquidity of farm loans (as measured by the time they remained outstanding) and such factors as the type of farming conducted by borrowers, the purpose and size of loans, and the year in which they originated. No consistent correlation with the first named factor was discernible, probably because most of the sample borrowers carried on more or less diversified farming operations.

Purpose of Loan—Comparison of the number of months required for the repayment of 2,283 loans classified according to the purposes previously listed, showed that three-fourths of the loans for such crop production uses as labor and machine hire, spray material, seed and fertilizer were repaid within 6 or 7 months. A slightly longer period—8 months—was required for the liquidation of the same proportion of loans for purchase of livestock and feed, reflecting the naturally slower maturing of marketable livestock than of crops. In the case of borrowings for such durable objects as farm machinery, automobiles and building improvements, repayment periods for 75 per cent of such loans ran up to 12 or more months, and note renewals were more frequent in these cases.

While with loans of such productive character, a fairly definite correlation is observable between typical repayment periods and the natural self-liquidating period of the related farm operations, a very considerable proportion of loans were made for purposes which do

*"Loans" in this connection, as elsewhere in the report, do not include farm real estate mortgage loans.

not in themselves contribute to cash income. Thus borrowings to meet payment of taxes, interest and insurance premiums are clearly not of a self-liquidating character, but represent rather recourse to bank credit for bridging the gap between the fixed due dates of such financial obligations and the realization of cash income from farm production. Similarly, loans for such consumption purposes as family living expenses, household furnishings, and medical, hospital, and funeral expenses, depend for their repayment, not on the results of the use to which the borrowed funds are applied, but upon future income from other sources. In loans of those types the proportion repaid within given periods was found to be more closely related to the size than to the purpose of the loan.

Size of Loans—When loans were classified by size, it was found that for every size group up to \$500, the smaller the amount of the loan, the greater was the proportion of such loans which were repaid within a given time period. Small loans, irrespective of purpose, can evidently be more readily repaid out of current income and the normal course of farm marketing. It was found, however, that loans for amounts over \$500 generally proved to be more liquid than those in the \$250-\$500 size-group. This may be partly accounted for by the fact that the bulk of the former represented self-liquidating loans for purchase of feeder cattle and labor and machine hire and that these larger loans were presumably made to a select class of borrowers. On the other hand, many of the loans in the \$250-\$500 group appear to represent borrowings by small-scale farmers who are more or less continuously dependent on the bank for working capital.

Time of Borrowing—Reference has already been made in this report to "cyclical variations in bank credit to farmers." Comparison of the years in which sample loans originated with the proportion repaid within twelve months after signing of original note presents the following picture.

Phase of Cycle	Year of Loan Origin	Number of Loans	Per Cent of Number of Loans Repaid within 12 Months
Prosperity	{ 1928	208	82.1
	{ 1929	229	74.7
Depression and Deflation	{ 1930	225	76.6
	{ 1931	281	69.9
	{ 1932	259	85.8
Recovery	{ 1933	172	95.3
	{ 1934	227	93.8
	{ 1935	369	91.4

Analysis of the foregoing data suggests that cyclical variations in the liquidity of farm loans are essentially a reflection of discrepancy between the conditions and expectations prevailing at the time when loans are sought and granted, and those developing as repayments become due. In the "prosperity" phase many farmers are disposed to

seek a larger volume of credit for financing expansions in both production and consumption, while banks are inclined to be more responsive to such applications on the basis of current values of borrowers' assets. So long as farm income continues at a relatively high level, liquidity is reasonably satisfactory, but when farm prices show a persistent downward trend and income realizations and expectations shrink, contraction occurs in the volume of new loans, and the extent to which outstanding loans are repaid represents forced liquidation rather than natural liquidity, with forced sales tending to further depress prices. At the bottom of the depression phase and in the earlier stages of the recovery phase both borrowers and lenders are cautious in respect to new loans, but capacity to repay improves in general as income recovers. Hence the liquidity rate tends to be highest, and at the same time less associated with forced liquidation, in the turning point and recovery phase of the cycle, and loans can generally be made with greater safety at this stage than at the height of the prosperity phase.

This experience suggests that at the present time when farm prices and incomes are rising sharply under the impact of the government defense and "lease-lend" programs, Michigan farmers should seek to apply their improved incomes to the repayment or reduction of outstanding obligations, and that new borrowings should be restricted as far as possible to directly productive purposes. Rising costs for farm labor may in certain cases economically justify the use of credit for acquiring additional farm machinery, especially of the general service type. Where this is contemplated farmers might advantageously compare the actual cost of credit under the terms required by equipment companies with that involved in borrowing from banks or Production Credit Associations to finance purchase from dealers on a cash basis. Competition since 1936 of Production Credit Associations with country banks has served to bring about a reduction in interest rates to farmers on loans for production purposes. It has also served to give farm borrowers greater opportunity for having note maturity or installment dates arranged to correspond more closely with income expectations and capacity to repay. Such arrangements are in accordance with the principles of true liquidity.

ANALYSES OF VARIOUS PORTIONS OF FROZEN HOMOGENIZED MILK

G M TROUT
SECTION OF DAIRY HUSBANDRY

In studying the freezing of homogenized milk and its appearance after thawing, many analyses were made of various portions of the partially frozen milk and of the several layers of the thawed product. These analyses, presented herewith, furnish specific data on the movement of fat and solids-not-fat in whole and in skim milk as a result of freezing and thawing of the milk homogenized at various pressures.

Table 1. The effect of homogenization on the concentration of milk solids by partial freezing at 0° F. for 3 hours (Av. 5 trials).

Constituent	Percent fat, solids-not-fat, and total solids in unfrozen and frozen portions of bottled milk when homogenized at—															
	0 lb.				500 lb.				1500 lb.				2500 lb.			
	U*	F*	Dif**		U*	F	Dif		U*	F	Dif		U*	F	Dif	
Fat.....	2.48	4.60	+2.12		4.18	3.50	-0.68		4.39	3.50	-0.80		4.38	3.60	-0.78	
SNF.....	10.19	7.39	-2.80		10.17	7.60	-2.57		10.18	7.63	-2.53		10.10	7.51	-2.59	
TS.....	12.67	11.99	-0.68		14.35	11.10	-3.25		14.48	11.13	-3.33		14.48	11.11	-3.37	
Percentage increase or decrease from the average test of the milk (3.8 percent fat)																
Fat.....	-1.32	-0.80	+0.38		-0.30	-0.50	-0.30		-0.30	-0.58	-0.20		+0.62	+0.20	-0.20	
SNF.....	+1.49	-1.31	-1.47		-1.10	-1.48	-1.03		-1.03	+1.40	-1.19		+1.45	+1.19	-1.19	
TS.....	+0.17	-0.51	-1.85		-1.4	-1.98	-1.33		-1.33	-1.98	-1.39		+2.07	+1.45	-1.39	
Milk heated to 200°F. for 5 minutes																
Fat.....	4.12	3.56	-0.56													
SNF.....	9.28	7.41	-1.87													
TS.....	13.40	10.97	-2.43													

*U, unfrozen; F, frozen.

**Plus or minus with respect to unfrozen portion

5.4 percent frozen after 3 hours at 0°F.)

Table 2. Effect of partial freezing (3 hours at 0° F.) on distribution of titratable acidity when the milk was homogenized at various pressures (Av. 3 trials).

Homogenization pressures (lb.)	The percent titratable acidity of the frozen and unfrozen portions of milk when homogenized at various pressures	
	Unfrozen	Frozen
0	0 21	0 14
500	0 20	0 15
1500	0 20	0 15
2500	0 20	0 15
3500	0 20	0 15

As previously pointed out (1) (2), freezing and thawing of homogenized milk causes settling of the fat and solids-not-fat, thus resulting in a watery appearance of the upper layer. Of chief importance was the fact that creaming did not occur in thawed frozen homogenized milk nor was flakiness observed on the sides of the container following freezing and thawing as usually noted in frozen unhomogenized milk. The data presented here were the bases for the following summary (2):

"When creaming was inhibited by heating or by homogenization the unfrozen portion was relatively richer in fat and solids-not-fat than the frozen portion. When creaming occurred, as in the unhomogenized milk, the frozen portion was higher in fat but lower in solids-not-fat than the unfrozen portion.

"The titratable acidity of the unfrozen portion was higher than the frozen portion regardless of creaming. No evidence of creaming was noted in frozen homogenized milk but rather a pronounced settling of the fat which was influenced by the rate of thawing.

"Frozen homogenized milk upon thawing exhibited no flakiness which was commonly observed when unhomogenized milk was frozen and thawed, but did exhibit a watery appearance at the surface layers which was more pronounced when the frozen milk was thawed slowly.

"Marked settling of the fat and solids-not-fat of milk was noted when homogenized milk was frozen and then thawed. The rate of thawing had a pronounced influence upon the extent of settling of the fat and solids-not-fat; the lower 15 per cent of creaming cylinders of slowly thawed frozen homogenized milk contained as high as 7.7 per cent fat and 24.60 per cent total solids as contrasted to 2.0 and 5.50 per cent respectively of the upper 15 per cent layer. The titratable acidity of the upper and lower 15 per cent portions ranged from 0.04 to 0.35 per cent. Similar trends were observed upon freezing and thawing of skimmed milk. When milk was heated to inhibit creaming, was frozen and thawed, the fat tended to rise to form a cream layer, a contrast to the movement of fat in the thawed frozen homogenized milk.

"The drainage of solids from homogenized milk was slightly faster after the first 100 ml. than that of the unhomogenized milk."

Table 3. The effect of freezing and thawing upon the homogeneity of whole milk homogenized at various pressures when thawed under different conditions (Av. 5 trials).

Constituent	Percent fat, solids-not-fat, and total solids in the upper and lower halves of 100 ml. creaming cylinders of milk homogenized at the following pressures when frozen and thawed under different conditions									
	0 lb.		500 lb.		1500 lb.		2500 lb.		3500 lb.	
	U**	L**	Dif ***	U	L	Dif	U	L	Dif	L
Unfrozen, creamed for 48 hours at 40°F										
Fat	6.78	0.94	-5.84	4.10*	3.35*	-0.75	3.98	3.74	-0.24	3.91
SNF	8.46	8.87	+0.41	8.60*	8.80*	+0.20	8.63	8.60	-0.04	8.71
TS	15.24	9.81	-5.43	12.59	12.11	-0.48	12.61	12.34	-0.27	12.62
Creamed 24 hours, frozen solid, thawed slowly in air at room temperature, creamed another 24 hours										
Fat	5.20*	1.70*	-3.50	2.88	4.72	+1.84	2.83	4.84	+2.01	2.85
SNF	5.58*	11.60*	+6.02	6.04	11.13	+5.09	6.10	11.13	+5.03	6.17
TS	11.11	13.28	+2.17	8.92	15.85	+6.93	8.93	15.97	+7.04	9.02
(Creamed 24 hours, frozen solid, thawed rapidly in water bath at 100°F, creamed another 24 hours)										
Fat	5.30*	2.20*	-3.10	3.65*	3.85*	+0.20	3.70	4.08	+0.38	3.60
SNF	8.56*	9.02*	+0.46	7.87*	9.21*	+1.34	7.93	9.23	+1.30	7.72
TS	14.11	11.09	-3.02	11.45	13.23	+1.78	11.63	13.31	+1.61	11.32

*Average of less than five trials

**U, upper; L, lower.

***Lower portion plus or minus as compared to the upper portion

Table 4. The effect of freezing and thawing on the homogeneity of whole milk homogenized at various pressures when thawed under different conditions.

Constituent	Percent fat, solids-not-fat, total solids and titratable acidity in various portions of creaming cylinders of milk homogenized at the following pressures when frozen and thawed under different conditions											
	0 lb.			500 lb.			1500 lb.			2500 lb.		
	U*	M	L	U	M	L	U	M	L	U	M	L
Unfrozen, creamed 48 hours at 40°F												
Fat.....	2.9	1.0	4.7	3.9	3.2	4.4	3.9	3.7	3.8	3.8	3.8	3.8
SNF.....	8.48	8.50	7.62	8.64	8.64	7.62	8.62	8.44	8.59	8.62	8.51	8.38
TS.....	18.70	11.39	9.50	12.32	11.84	12.02	12.52	12.14	12.47	12.39	12.31	12.18
Acidity.....	0.15	0.15	0.15	0.14	0.14	0.15	0.14	0.14	0.15	0.14	0.15	0.14
(Creamed 24 hours; frozen solid, thawed slowly in air at 70°F, creamed another 24 hours)												
Fat.....	11.5	1.2	1.7	3.9	7.0	1.7	3.8	7.7	1.7	4.2	7.7	7.7
SNF.....	3.41	8.35	13.01	1.81	17.46	3.09	7.35	16.90	2.58	7.22	3.50	16.51
TS.....	14.01	9.55	15.61	5.71	10.96	4.79	11.15	24.60	4.28	11.42	5.50	24.21
Acidity.....	0.08	0.14	0.28	0.05	0.13	0.04	0.13	0.35	0.05	0.14	0.07	0.35
(Creamed 24 hours; frozen solid, thawed rapidly in water bath at 100°F, creamed another 24 hours)												
Fat.....	7.8	3.2	1.9	3.7	4.0	3.0	4.0	4.9	2.8	3.8	5.4	5.3
SNF.....	5.39	7.77	11.87	5.43	8.08	5.97	8.37	11.53	5.52	8.23	5.94	8.01
TS.....	13.19	10.97	13.77	9.13	12.08	8.97	12.37	16.43	8.32	12.03	8.74	12.01
Acidity.....	0.10	0.13	0.24	0.10	0.14	0.10	0.14	0.23	0.10	0.14	0.09	0.23

*U, upper 15 percent, M, middle 70 percent, and L, lower 15 percent.

Table 4a. The effect of freezing and thawing on the homogeneity of whole milk heated to inhibit creaming when thawed under different conditions.

Constituent	Percent fat, solids-not-fat and total solids of various portions of milk heated to 200°F. when -								
	unfrozen			frozen, thawed slowly			frozen, thawed rapidly		
	U*	M	L	U	M	L	U	M	L
Fat....	10 92	2.30	0.42	7 94	2.86	1 20	10.32	2.66	0 48
SNF.....	9 15	8 43	8 79	4 44	7.37	16 26	5 62	8.18	11 54
TS.....	20 07	10 73	9 21	12 38	10 23	17.46	15.94	10 84	12.02

*U, upper 15 percent; M, middle 70 percent and L, lower 15 percent

Literature Cited

- (1) Trout, G. M., Watery appearance of frozen homogenized milk. Mich. Agr. Exp. Sta. Quart. Bul. **23**: 10-19, 1940.
- (2) Trout, G. M., The freezing and thawing of milk homogenized at various pressures. J. Dairy Sci., **24**: 277, 1941.

Table 5. The effect of freezing and thawing upon the homogeneity of skimmilk homogenized at various pressures when thawed under different conditions (Av. 2 trials).

Treatment of sample	Percent total solids in the upper and lower halves of 100 ml creaming cylinders of skimmilk homogenized at—													
	0 lb		500 lb		1500 lb.		2500 lb		3500 lb.		Dif.	L	U	Dif.
	U*	L*	Dif**	U	L	Dif	U	L	Dif	U				
Unfrozen	8.54	8.61	+0.07	8.99	9.13	+0.14	8.96	9.19	+0.23	8.99	9.09	8.94	8.98	+0.04
Frozen—thawed slowly	5.03	11.94	+6.91	5.75	12.25	+6.55	5.53	12.53	+7.00	5.73	12.25	5.59	12.32	+6.73
Frozen—thawed rapidly	7.79	9.72	+1.92	7.96	12.22	+4.26	7.85	10.22	+2.37	7.87	10.25	8.03	10.15	2.10

*U, upper; L, lower.

**Lower portion plus or minus as compared to the upper portion.

Table 6. The effect of freezing and thawing on distribution of titratable acidity of milk homogenized at various pressures when thawed under different conditions (Av. 3 trials).

Treatment of sample	Percent titratable acidity of upper and lower halves of 100 ml creaming cylinders of milk homogenized at the following pressures when frozen and thawed under different conditions									
	0 lb.		500 lb.		1500 lb.		2500 lb		3500 lb	
	U*	L*	U	L	U	L	U	L	U	L
Unfrozen	0 167	0 167	0 170	0 168	0 175	0 172	0 170	0 170	0 170	0 173
Frozen—thawed slowly .	0 093	0 233	0 110	0 223	0 110	0 223	0 117	0 227	0 113	0 223
Frozen—thawed rapidly..	0 143	0 187	0 153	0 183	0 147	0 183	0 147	0 187	0 16	0 183

*U, upper 50 ml ; L, lower 50 ml

Table 7. The fat content of respective 100 ml. portions of drainage from frozen quart sealrights of whole milk homogenized at various pressures (Av. 3 trials).

Order of sample	The percent fat in 100 ml samples of drainage from frozen milk when homogenized at—				
	0 lb.	500 lb.	1500 lb	2500 lb	3500 lb
1st.....	6 70	7 60	7 47	7 40	7 17
2nd.....	4 63	5 40	5 30	5 77	5 26
3rd.....	4 10	5 53	5 87	5 67	5 90
4th.....	3 80	5 30	5 93	6 13	6 23
5th.....	3 37	4 77	4 53	5 60	5 77
*Remainder (App. 500 ml)	1 90	1 00	1 00	1 10	0 80

*One trial

Table 8. The solids-not-fat content of respective 100 ml. portions of drainage from frozen quart sealrights of whole milk homogenized at various pressures (Av. 3 trials).

Order of sample	The percent of fat in 100 ml. samples of drainage from frozen milk when homogenized at—				
	0 lb.	500 lb.	1500 lb	2500 lb	3500 lb.
1st.	17 13	15.65	15.31	15.03	15 61
2nd.	13.07	11.97	11 91	12 63	10 57
3rd	12 00	12.05	12.70	12 45	12 60
4th	12.02	12.05	13 33	14 09	13 42
5th	11 47	11 09	14 70	12.66	13.30
*Remainder (App. 500 ml) . .	2 68	2 28	1 91	2 32	1.42

*One trial

Table 9. The total solids content of respective 100 ml. portions of drainage from frozen quart sealrights of whole milk homogenized at various pressures (Av. 3 trials).

Order of sample	The percent total solids in 100 ml. samples of drainage from frozen milk when homogenized at—				
	0 lb	500 lb	1500 lb	2500 lb	3500 lb
1st	23 83	23 25	22 78	22 43	22 78
2nd	17 70	17 37	17 21	18 40	16 83
3rd	16 10	17 58	18 57	18 12	18 50
4th	15 82	17 35	19 26	20 22	19 65
5th	14 84	15 86	19 23	18 26	19 53
*Remainder(App. 500 ml) . .	4 58	3 28	2 91	3 42	2 22

*One trial

Table 10. The titratable acidity of respective 100 ml. portions of drainage from frozen quart sealrights of whole milk homogenized at various pressures (Av. 2 trials).

Order of sample	The percent titratable acidity in 100 ml. samples of drainage from milk homogenized at—				
	0 lb.	500 lb	1500 lb	2500 lb.	3500 lb.
1st.....	0 3555	0 335	0 340	0 325	0 320
2nd.....	0 260	0 225	0 245	0 250	0 240
3rd.....	0 245	0 290	0 285	0 270	0 295
4th.....	0 280	0 280	0 300	0 295	0 310
5th.....	0 245	0 235	0 285	0 295	0 305
*Remainder (App. 500 ml)	0 035	0 025	0 020	0 025	0 020

*One trial

Table 11. The total solids of respective 100 ml. portions of drainage from frozen quart sealrights of skimmilk homogenized at various pressures (Av. 2 trials).

Order of sample	The percent total solids in 100 ml. samples of drainage from frozen skimmilk homogenized at—				
	0 lb	500 lb	1500 lb	2500 lb	3500 lb
1st.....	16 35	20 86	22 61	20 21	22 02
2nd.....	14 32	15 15	14 99	14 78	14 98
3rd.....	12 63	13 19	13 00	15 50	14 65
4th.....	12 07	12 89	11 53	13 27	12 64
5th.....	9 90	9 99	9 37	10 85	9 84
*Remainder....	3 32	1 69	2 61	1 50	2 25

*One trial.

SPELT EQUALS OATS FOR FEEDING PIGS

V A FREEMAN
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Results from three trials indicate that winter spelt is about equal to oats for feeding pigs.

Four lots of fall pigs were fed during each of the past three winters to compare the feeding value of spelt with oats. Because of the high fiber content of both feeds, corn was added, Lot 1 receiving 50 per cent spelt and 50 per cent corn, Lot 2 receiving 25 per cent spelt and 75 per cent corn, Lot 3, 50 per cent oats and 50 per cent corn, and Lot 4, 25 per cent oats and 75 per cent corn. All lots received the same supplement, which was composed of 40 pounds of tankage, 30 pounds of soybean oil meal, 20 pounds of ground high-quality alfalfa, and 10 pounds of dried skimmilk. The grains were mixed and fed in one compartment of the feeder and the supplement fed in another compartment, the pigs having free access to both in the first trial. In the other two trials, 4 parts of grain were mixed with 1 part of supplement. All lots had access to self-waterers and a mineral mixture composed of equal parts of steamed feeding bonemeal, finely ground limestone, and salt. Very small amounts of the mineral were taken by any of the lots.

The average result in the gain, average daily ration and feed required per hundredweight of gain are given in Table 1.

Table 1. Spelt versus oats for pigs (average results of 3 trials).

Lot Number and Grains Used	1	2	3	4
	Spelt 50% Corn 50%	Spelt 25% Corn 75%	Oats 50% Corn 50%	Oats 25% Corn 75%
*Number of pigs	19	19	19	19
Initial weight of pigs	53.8	53.5	54	53.9
Final weight of pigs	195.2	192.6	185.1	193.7
Daily gain	1.32	1.27	1.11	1.23
Daily ration:				
Ground corn	2.40	3.35	1.91	3.05
Ground spelt	2.40	1.11		
Ground oats			1.91	1.01
Supplement	.93	.91	.78	.84
Mineral	.01	.01	.01	.01
Total	5.74	5.38	4.61	4.91
Feeds consumed per 100 pounds of gain:				
Ground corn	181.2	262.7	172.9	247.1
Ground spelt	181.2	87.6		
Ground oats			172.9	82.4
Supplement	70.3	71.4	70.7	68.4
Minerals	.6	.7	.7	.6
Total	433.3	422.4	417.2	398.5

*Total used in 3 trials.

The pigs averaged approximately 54 pounds at the beginning of the experiment and were fed to approximately 190 pounds of weight. The pigs in Lot 1, receiving equal parts of spelt and corn, made the highest rate of gain, averaging 1.32 pounds per head daily as compared with 1.27 pounds for Lot 2, 1.11 pounds for Lot 3, and 1.23 pounds for Lot 4. Both lots fed spelt and corn consumed more feed daily than did the lots fed oats and corn. Lot 1 consumed 5.7 pounds daily as compared with 4.6 pounds for Lot 3, and Lot 2 consumed 5.4 pounds daily as compared with 4.9 for Lot 4. This apparent palatability of spelt as compared with oats probably accounts for the superior rate of gain for the spelt-fed pigs.

There was a small difference in the total amount of feed per 100 pounds of gain. The greatest amount of feed for gains was required by Lot 1, fed 50 per cent spelt and 50 per cent corn, and the smallest amount was required by Lot 4, receiving the 25 per cent oats and 75 per cent corn in their grain mixture. The two oat-fed lots averaged 20 pounds less total feed per 100 pounds of gain than did the two spelt-fed lots.

The apparent efficiency of the oat ration as compared to spelt may be accounted for by the lower amount of feed consumed daily. If instead of self-feeding Lots 1 and 2, their ration had been limited to amounts consumed by Lots 3 and 4, their efficiency might have equaled that of the oat-fed lots. It is likely that the increased rate of gain and shorter feeding period for the spelt-fed lots is of greater value than the disadvantage of their slightly greater feed required for gains.

These trials would indicate that spelt is approximately equal to oats for feeding growing pigs.

The average chemical analysis of the spelt in two trials was as follows:

	MOISTURE	PROTEIN	CRUDE FIBER
Spelt	11.44%	11.35%	10.98%

INFLUENCE OF THE METHOD OF SAMPLING ON THE ACCURACY OF THE ACIDITY TEST OF SOUR CREAM

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The correct procedure for determining the acidity of dairy products involves the weighing of the sample upon which the titration is to be made inasmuch as the acidity determination is based upon weight rather than upon volume. In the case of milk, skimmilk and whey, however, the general practice is to titrate the sample delivered either by a 17.6-ml. or a 9-ml. pipette, assuming that the samples weigh 18 grams and 9 grams, respectively. The acidity errors involved in such an assumption, in the case of milk and products of similar viscosity,

are not great, with somewhat greater errors occurring in the case of the smaller sample.

Because it is possible to determine the acidity of milk rather accurately by titration of a volumetrically-measured rather than a weighed sample, the same practice has been followed by many workers in determining the acidity of other dairy products. This is particularly true in the case of sour cream where often the titration is made upon a sample of cream as delivered normally by a 9-ml. cream pipette. This is done even though present-day recommendations call for the weighing of a 9-gram sample for the titration procedure. The plant man, however, often feels that there is not sufficient difference in accuracy between the two methods to warrant the additional time required for the weighing procedure.

Information dealing with the possible influence of methods of sampling of sour cream on the accuracy of the results is scarce, although Weckel (1) has conducted such a study on sweet cream. Therefore, in order to obtain information on this subject, about 264 samples of cream were tested for acidity, the acidity procedure varying only insofar as the method of sampling was concerned. The results of such a study are herein reported.

Experimental Procedure—Cream used in this study was individual patron's cream collected at random from the supply of the Michigan State College Creamery. Such cream is generally sour cream, typical of that obtained by many commercial creameries, and is delivered directly to the College Creamery by the producers. Samples were obtained from the cream at the time of delivery and were stored at 35-40° F. until analyzed. Prior to the analysis, the samples were warmed to 70-75° F., and mixed thoroughly. They were tested for fat by the Babcock method and for acidity. The acidity was determined in samples of cream obtained in the following manner:

1. Weighed sample: This was a 9-gram sample weighed directly into the titration dish.
2. Volume sample: This sample was delivered by means of a 9-ml. cream pipette, the pipette being drained and blown out. No extra precautions were taken to remove all of the cream. This sample would represent somewhat less than 9 ml. of cream.
3. Volume-rinsed sample: This sample consisted of the cream delivered from a 9-ml. cream pipette plus the rinsings from the pipette. This rinsing was accomplished by means of about 7-9 ml. of warm water (temperature 90-100° F.) which were drawn up into the pipette after the cream had been drained out. The pipette was inverted once or twice (keeping the index finger firmly over the large end of the pipette to prevent excessive loss) and then these rinsings were added to the sample.

Other than differences in the method of securing the sample, the acidity determinations were conducted in the same manner. About 5 drops of phenolphthalein were added to the sample and the titration made with one-tenth normal sodium hydroxide. The results are expressed as per cent lactic acid.

Experimental Results

Acidity and Fat Relationship—The acidity results obtained on the weighed, volume, and volume-rinsed samples in relation to differences in fat content of the cream are shown in Table 1.

Table 1. Acidities of cream of various fat contents when determined on weighed, volume, and volume-rinsed samples.

Fat Content (%)	Number of Samples	Type of Sample		
		Weighed	Volume	Volume-rinsed
		Acidity (%)		
29.5 or less.....	69	0 475	0 420	0 472
30—39.5.....	135	0 523	0 455	0 515
40 or more.....	60	0 431	0 356	0 419
All samples....	264	0 490	0 423	0 483

These data show that both the volume and the volume-rinsed samples gave acidity values consistently less than the values for weighed samples for all fat levels, but with the volume-rinsed samples deviating to a much less extent. In fact, the volume-rinsed samples averaged only 0.003 per cent less than the weighed sample at the fat level of 29.5 per cent or less and only 0.012 per cent at the fat levels of 40 per cent or more. For the same fat levels, the volume samples were less than the weighed samples by 0.055 and 0.075 per cent, respectively. For all samples, the average acidity values for the weighed, volume, and volume-rinsed samples show the volume and volume-rinsed samples to average 0.067 per cent and 0.007 per cent respectively below the weighed samples. In general, the results in Table 1 show that as the fat content of cream increases the discrepancies between the

Table 2. Acidities of cream of different acidity levels when determined on weighed, volume, and volume-rinsed samples.

Acidity Ranges (%)	Number of Samples	Type of Sample		
		Weighed	Volume	Volume-rinsed
		Acidity (%)		
0.295 or less.....	41	0 217	0 203	0 213
0.30—0 395.....	41	0 348	0 319	0 337
0 40—0 495.....	55	0 441	0 389	0 432
0 50—0 595.....	62	0 543	0 457	0 538
0 6 or over.....	65	0 684	0 571	0 669
All samples.....	264	0 490	0 423	0 483

weighed and the other samples increase, but the values for the volume-rinsed samples are close to those secured on the weighed samples irrespective of fat content.

Acidity Values and Acid Level Relationship—Inasmuch as the acidity content of the cream might be expected to influence the accuracy of the acidity determination, attention was directed to this possibility. The relationship between the acidity determinations and the acidity level of the cream is shown in Table 2.

The values in this table again show that although the results by the volume and volume-rinsed samples are lower than those of the weighed samples, the results on volume-rinsed samples average close to those obtained on the weighed samples. Further, the values show that more divergence between the results of the weighed and the other samples occurs with increasing acidity. For example, the volume samples varied from the weighed samples by only 0.014 per cent at the acidity level of 0.295 or less, whereas at the level of 0.60 or over the difference was 0.111 per cent. A similar but less marked trend may be observed in the case of the volume-rinsed samples.

A further and more complete analysis of the results obtained in this study is given in tables 3 and 4. These tables show the deviation of the acidity results by the volume and volume-rinsed samples from the weighed samples, and also show how the deviations are influenced by the level of fat and acidity. A general perusal of these tables will show that the volume samples deviated to a greater extent than the volume-rinsed samples at all fat and at all acidity levels.

In Table 3 it is shown that from 20 to 30 per cent of the volume samples varied 0.1 per cent or more from the weighed samples, whereas the volume-rinsed samples practically all varied less than 0.04 per cent. Further, as noted in regard to Table 1, the data in Table 3 show that the volume samples deviated somewhat more from the weighed samples as the fat content increased. This is to be expected since decreases in weight per unit volume of the cream and increases in viscosity occur

Table 3. Deviation in acidity of volume and volume-rinsed samples from weighed samples in cream of various fat contents.

Fat Ranges	Percent of Samples Varying Within the Ranges of					
	0.2 or less	0.21- 0.4	0.41- 0.6	0.61- 0.8	0.8-0.1	> 0.1
Volume Samples						
29.5 or less	39.13	17.39	8.70	5.80	8.70	20.29
30-39.5	22.22	14.07	17.78	17.78	6.67	21.48
40 or over	21.67	18.33	18.33	6.67	3.33	31.67
Volume-rinsed Samples						
29.5 or less	88.41	11.59	—	—	—	—
30-39.5	83.70	15.56	0.74	—	—	—
40 or over	90.00	6.67	1.67	—	—	1.66

Table 4. Deviation in acidity of volume and volume-rinsed samples from weighed samples in cream of various acidities.

Acidity Ranges	Percent of Samples Varying Within the Ranges of					
	<0.2 or less	.021-.04	.041-.06	.061-.08	.08-.1	> 0.1
	Volume Samples					
(%)						
0.295 or less	73 17	19.51	7 32	—	—	—
0.30-0.395	43.90	26 83	19 51	7 32	—	2.44
0.40-0.495	18 18	14.55	30 91	16.36	7 27	12.73
0.50-0.595	14.52	12 90	14 52	17.74	8 06	32 26
0.6 or over	4.62	10.77	6.15	13 85	12 31	52.31
	Volume-rinsed Samples					
0.295 or less	100	—	—	—	—	—
0.30-0.395	97 56	2 44	—	—	—	—
0.40-0.495	90 91	9 09	—	—	—	—
0.50-0.595	70 97	27 42	1 61	—	—	—
0.6 or over	81 54	15 38	1 54	—	—	1 54

with the fat increases. Both of those factors would cause a decrease in the weight of cream delivered by the pipette. In Table 4, the deviation of the volume samples from the weighed samples is shown to vary directly with the acidity content of the cream. In cream having acidities of 0.6 per cent or more, somewhat more than 50 per cent of the determinations showed a difference of 0.1 per cent or more between the weighed and volume samples. In contrast to this and at the same acidity level approximately 97 per cent of the volume-rinsed samples varied from the weighed samples by not more than 0.04 per cent.

The deviation of all of the volume and volume-rinsed samples from the weighed samples, disregarding the fat and acidity levels of the samples, is portrayed graphically in Figs. 1 and 2. Figure 1 shows the percentage distribution of the volume and volume-rinsed samples having results varying either above or below those obtained on the weighed samples. This graph illustrates the fact that virtually all of the volume samples gave low values in comparison to the results on the weighed samples. The volume-rinsed samples also tend to give low values with 52 per cent of the variation being under the weighed-sample values and about 20 per cent giving values being higher.

Figure 2 shows the normal distribution of all of the samples. It may be observed that about 27 per cent of the volume-rinsed samples gave results identical with those obtained on the weighed samples, whereas only about 4 per cent of the volume samples gave identical values. Further, about 87 per cent of the volume-rinsed samples varied not more than 0.02 per cent whereas only about 27 per cent of the volume samples were within this range. In the ranges of 0.05 per cent or more are found some 58 per cent of the volume samples, whereas practically none of the volume-rinsed samples deviated from the standard to this extent.

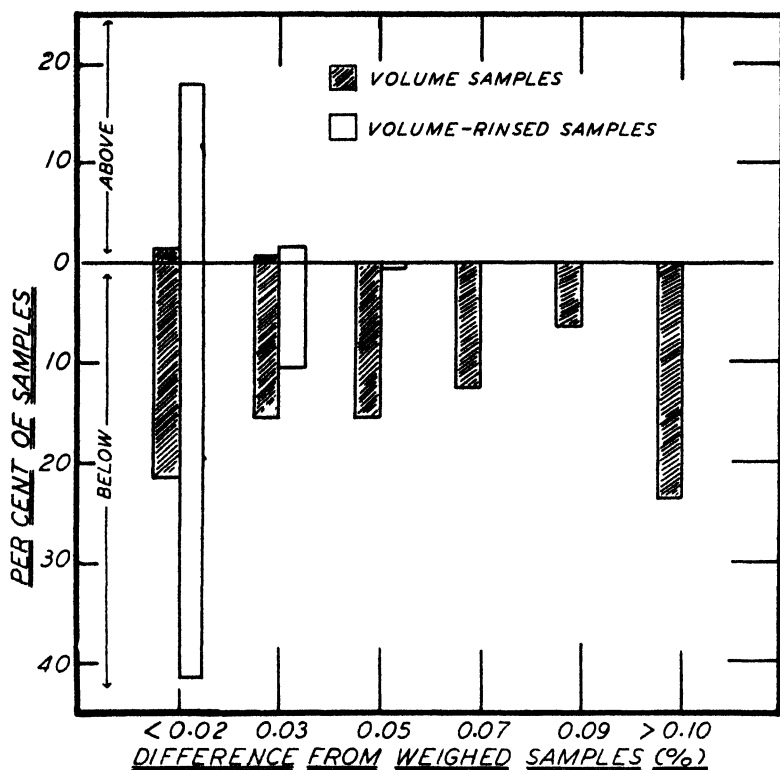


Fig. 1. Distribution of volume and volume-rinsed samples showing variation above and below the weighed samples.

(Note: Values on abscissa showing differences from weighed samples represent the center of the range: i.e. 0.03 represents differences of 0.021 - 0.04, 0.05 represents differences of 0.041 - 0.06, etc.)

Summary and Conclusions

Analyses of 264 samples of sour cream for acidity were made (a) on 9-gram samples, (b) on volume samples consisting of approximately 9 ml. delivered by a 9-ml. cream pipette, and (c) on volume samples as in (b) but with the rinsings from the pipette included. The average of all results were as follows: weighed samples 0.490; volume samples 0.423; volume-rinsed samples 0.483.

The results for the volume-rinsed samples agreed closely with the results obtained on the weighed samples, with approximately 87 per cent varying by no more than 0.02 per cent. In contrast, the results for the volume samples varied considerably from the weighed-sample results, with 73 per cent varying more than 0.02 per cent and about 23 per cent varying by 0.1 per cent or more.

Increasing the fat content of the cream or increasing the acidity content results in greater deviation of the volume-sample results from the weighed-sample results. The volume-rinsed samples also tended to

deviate more with increases in fat and acidity, but the extent of the deviations was relatively insignificant.

These results indicate that appreciable errors in acidity determinations of sour cream may result when the sample is measured by a 9-ml. cream pipette and when no effort is made to add the rinsings to the sample. The results may be sufficiently in error to interfere appreciably with the accuracy of the neutralization process or with other processes where accurate acidity control is necessary.

Although the most accurate procedure in cream acidity determinations involves the use of a weighed sample, the results in this experiment indicate that the results may be accurate enough for all practical purposes if the rinsings from the 9-ml. pipette are added to the sample. Doubtless, the accuracy of this method would be affected in cases of extremely high-acid yeasty cream. The volume-rinse method is less time-consuming and somewhat more practical from plant operation than the weighing procedure. When the volume-rinse sample is

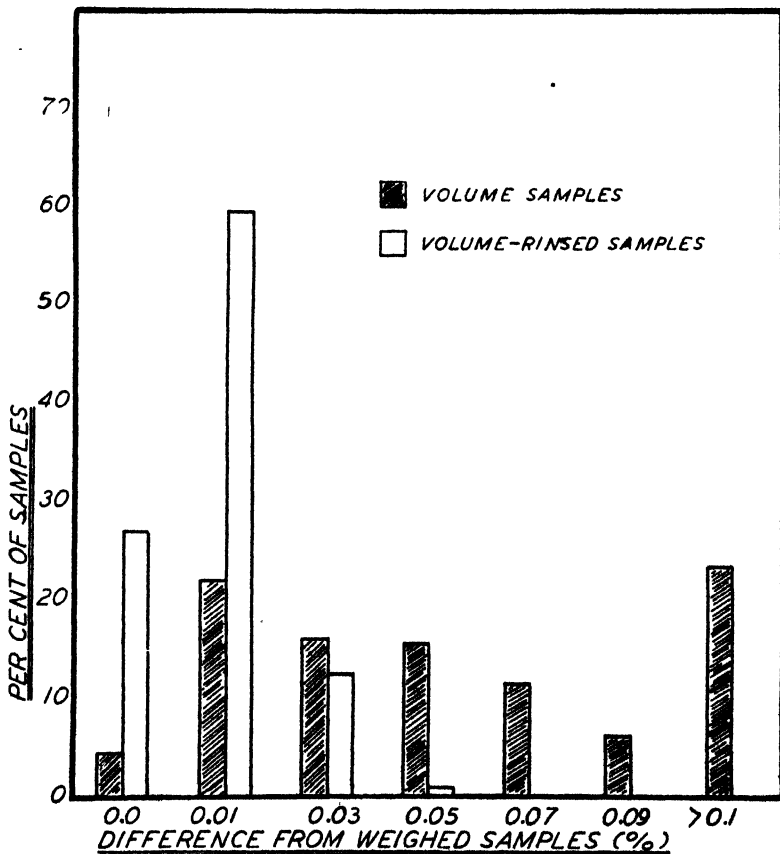


Fig. 2. Distribution of volume and volume-rinsed samples from weighed samples.

to be used, however, the operator should avoid excessive dilution of the sample with water, 7-9 ml. being sufficient, and should use clean, practically acid-free water for the rinsing operation.

Reference

- (1) Weckel, K. G., as cited by Sommer, H. H., "The Acidity of Dairy Products." Wis. Agr. Exp. Sta. Res. Bul. 127. 1935.

CULL BEANS AND COTTONSEED MEAL AS A SUPPLEMENT FOR WINTERING BREEDING EWES

LEONARD H. BLAKESLEE, G. A. BROWN AND J. G. WELLS, JR.
SECTION OF ANIMAL HUSBANDRY AND UPPER PENINSULA EXPERIMENT STATION

Breeding ewes, under normal conditions, can be wintered on good-quality legume hay, if $\frac{1}{2}$ to 1 pound of a good grain mixture is added 4 to 6 weeks before lambing.

The feeding of legume hay alone is an economical method of wintering breeding ewes when the hay is of good quality. As reported in the November 1937 Quarterly Bulletin, the addition of 0.6 pound of cottonseed meal daily to supplement 3 pounds of mixed hay of poor quality, resulted in an increase of 1.45 pounds of wool, and lambs which averaged 7.52 pounds heavier at weaning time, than did the fleeces and lambs from similar ewes fed 4 pounds of hay daily. Inasmuch as cottonseed meal fed as mentioned gives good results, it is reasonable to suppose that cull beans, a commonly available and rather cheap feed, high in protein, should give corresponding results. To obtain definite information on the value of cull beans for breeding ewes, the following test was made.

The flock of Hampshire and crossbred ewes at the Chatham Substation was divided equally into four lots with consideration given to condition, age, weight, breeding, shearing ability and thrift. This test was conducted for three years. Each fall, the breeding season started about November 1, and one month later the flock was divided into the four lots for winter feeding. An average of three successive daily weights was used as the initial and final weights for the gestation and nursing periods. Individual weights were taken each 28 days during the winter feeding period. Weights were taken on lambs at birth, when turned to pasture and at weaning time. Each lamb was ear-tagged at birth as a means of identification.

Table 1 gives detailed data on the ewes by lots during the gestation and nursing period.

The feeding plan for each lot was as follows:

Lot 1—Fed approximately 4 pounds of mixed legume hay per ewe daily until 3 to 4 weeks before lambing when 0.7 pound of a grain mixture was added.

Table 1. Three-year summary of average daily ration ewe weights and gains—1936-37; '37-38; '39-40.
Gestation Period.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Number of ewes on feed	83	83	83	43	43
Average days on feed	109	109	109	109	109
Average initial weight (lb)	157 32	155 88	154 92	156 38	156 11
Average final weight (lb)	172 48	172 25	178 37	175 48	174 14
Average gain per ewe (lb)	15.16	16 37	23 45	19 02	18 03
Average daily gain (lb)	13	.14	21	17	16
AVERAGE DAILY RATION (LB):					
Hay	4 20	3 24	3 24	3 26	3 21
*Grain mixture	67	65	.48	.66	---
Cottonseed meal	---	20	40	.20	---
Cull beans	---	---	---	40	.45
**Carrots . . . . .	.69	.69	.69	73	.73
***Molasses . . . . .	.20	.20	.20	20	20

Nursing Period.

Average number days fed	42	42	42	42	42
Lambing percent	142	149	134	137	151
AVERAGE DAILY RATION (LB):					
Hay	4 00	3 00	3 00	3 00	3 00
Grain mixture	69	69	.49	70	---
Cottonseed meal	---	20	40	20	---
†Roots	1 89	1 89	1 89	1 89	1 89
Cull beans	---	---	---	---	.86
††Molasses . . . . .	.21	.21	21	.22	21

*Fed just prior to lambing

**Fed 38 days at beginning of gestation period in 1939-40

***Fed 56 days prior to lambing in 1940 only

†Fed 29 days in 1937

††Fed first 14 days of 1939 lambing period

Lot 2—Fed about 3 pounds of mixed legume hay and 0.2 pound of cottonseed meal per ewe daily until 3 to 4 weeks before lambing when 0.7 pound of a grain mixture was added.

Lot 3—Each ewe was fed approximately 3 pounds of mixed legume hay daily and 0.4 pound of cottonseed meal until 3 to 4 weeks before lambing when 0.5 pound of the grain mixture was added.

Lots 4 and 5—Ewes were fed together on approximately 3 pounds of mixed legume hay and 0.4 pound of cull beans daily until 3 to 4 weeks before lambing. At this time in Lot 4 the cull beans were replaced with 0.7 pound of the grain mixture and 0.2 pound of cottonseed meal, while in Lot 5, the cull beans were increased to 0.9 pound.

Feeds Used

The grain mixture was composed of $\frac{1}{3}$ by weight bran and $\frac{2}{3}$ by weight oats the first year. During the second and third years, barley was used to replace oats. The hay fed was mixed grasses and legumes. This hay, put up under adverse conditions, was very coarse. Carrots and beet molasses were added to the ration during the gestation period of 1939-40. The cull beans were split and discolored, but free from foreign material. These beans were purchased from a Lansing elevator and shipped to Chatham.

Effect of Rations on Weight and Gains of Lambs

Because the greatest proportion of the income from sheep is derived from the lambs, the effect of a ewe's ration on the performance of her offspring should be carefully considered. All lots dropped an average of 1.33 lambs per ewe or better as indicated in Table 1. The per cent of lambs weaned was 107.22, 109.63, 107.22, 113.95 and 125.58 in Lots 1, 2, 3, 4 and 5, respectively, with an average for all of 111, or 1.11 lambs per ewe started on experiment. Based on ewes going to pasture, 1.18 lambs were weaned per ewe.

As indicated in Table 2, the average birth weight of all single lambs varied 2.03 pounds between lots, while the average weight of twin lambs varied only 0.95 pound. All lots receiving a supplement to hay showed a slight advantage in average birth weight of lambs, except Lot 5 twin lambs. This lot was fed cull beans to supplement 3 pounds of hay all through the gestation and nursing periods. The weights to pasture indicate a tendency of all lambs, from ewes receiving a supplement to hay, either to maintain or gain a weight advantage over the lambs from the ewes in Lot 1, receiving no supplement during the greater part of the gestation period.

Weaning weights in Table 2 show a continued increasing weight advantage of lambs from all lots over Lot 1. Considering the average weaning weight and average daily gains of all lambs, one finds that Lots 3 and 5, the dams of which received cottonseed meal and cull beans respectively as supplements to 3 pounds of hay, were about even and above all others.

Table 2. Average weights and gains of lambs 1937-38-40.

	Birth Weight (Pounds)			To Pasture Weight (Pounds)			Weaning Weight (Pounds)			Average Daily Gain (Pounds)
	All lambs	Single lambs	Twin lambs	All lambs	Single lambs	Twin lambs	All lambs	Single lambs	Twin lambs	All lambs
Lot 1, ...	8 88	9 58	8 64	18 63	21 69	17 12	61 21	64 92	59 5	416
Lot 2	9 29	10 93	8 65	19 98	21 98	18 48	64 64	73 34	57 52	457
Lot 3	9 97	11 61	9 36	21 76	24 15	20 64	69 65	80 53	64 65	475
Lot 4	9 27	10 56	8 75	21 65	22 33	21 2	65 53	68 52	63 28	453
Lot 5	8 81	10 58	8 41	19 25	21 9	18 44	69 2	77 26	66 10	476

Considering wool production, all lots receiving a protein supplement of either cull beans or cottonseed meal to 3 pounds of mixed hay averaged heavier in fleece weights than Lot 1, receiving 4 pounds of hay.

Summary

1. Five lots of breeding ewes for three different years were fed rations of hay, hay and cottonseed meal, and hay with cull beans in order to study the effect on wool production, lamb production and gain in ewe weights during the gestation period.

2. In this test, 0.4 pound of cull beans daily proved equal to 0.4 pound of cottonseed meal from the standpoint of lamb production of

ewes when fed as a supplement to hay during the entire gestation and nursing periods.

3. All lots of ewes receiving either cottonseed meal or cull beans as a supplement to 3 pounds of hay during the entire gestation period produced heavier fleeces and heavier lambs at weaning time than did the lot of ewes receiving only 4 pounds of hay daily.

4. In each case, added cost of feed was more than paid for by increased production of wool and lambs.

WHAT SHOULD BE THE LENGTH OF THE CALVING INTERVAL?

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A study of the records of 27 purebred Holstein cows in the herd at the Chatham sub-station of Michigan State College shows that only six have average calving intervals of 365 days or more. A calving interval in this study is the number of days from one freshening to the next. Only cows with one or more lactations were listed. Normal calvings only were considered.

Table 1 gives the number of lactation periods for each cow listed, the average number of days for her calving interval, the average

Table 1. The data for each cow.

Cow No	Total Lactation Periods	Average Length of Calving Interval (Days)	Average Pounds Fat per Lactation	Average Pounds Fat per Day During Each Calving Interval
185.....	6	360	416 5	1 15
189.....	4	360	377 8	0 94
273.....	3	340	453 5	1 33
280.....	1	388	332 6	0 86
281.....	5	356	372 1	1 04
282.....	7	359	465 5	1 20
283.....	4	352	407 6	1 16
288.....	2	333	366 6	1 10
292.....	5	351	463 4	1 32
297.....	5	358	458 3	1 28
300.....	5	349	383 6	1 09
306.....	2	347	288 1	.83
307.....	4	393	506 7	1 29
308.....	2	346	459 7	1 32
310.....	2	388	368 4	.95
311.....	4	377	405 8	1 07
316.....	3	323	383 1	1 18
319.....	3	358	413 2	1 15
320.....	3	344	427 1	1 24
325.....	3	348	423 5	1 10
327.....	3	345	447 1	1 29
340.....	1	348	324 7	.93
341.....	1	389	367 1	.94
342.....	1	337	389 7	1 15
343.....	1	364	395 0	1 08
345.....	1	322	341 2	1 06
346.....	1	387	457 6	1 18

pounds of fat produced per lactation period, and the average pounds of fat produced per day (including days dry).

It is noted that the highest average production per lactation period is 506.7 pounds of fat in four periods by cow No. 307. Her average length of calving interval was 393, the highest in the study. The five other cows whose calving intervals averaged above 365 days produced an average 332.6 pounds of fat to 457.6 pounds.

An interesting comparison can be made of the average daily fat production in the calving interval of those with periods above 365 days and those below that number. Table 2 gives analysis of the two groups.

Table 2. Variation in production due to length of calving interval.

Calving Interval	No. Cows	No. Cows Above 1 Pound Fat per Day	No. Cows Below 1 Pound Fat per Day
More than 365 days	6	3	3
Less than 365 days.	21	18	3

In the management of the Chatham herd, it has been the policy of the present herdsman to breed the cows at the first period following approximately six weeks after freshening. Six weeks are then allowed for a dry period. If each cow came in heat at exactly six weeks after freshening and conceived at the first service, the calving interval would average 325 days. In practice it is seen from Table 1, however, that actually only two cows, No. 316 and No. 345, show intervals of less than 330 days. An analysis of the length of days in the calving periods is shown in Table 3.

Table 3. Distribution of calving interval.

Length - days	No. Cows
322-329	2
330-339	2
340-349	8
350-359	6
360-365	3
More than 365	6

By breeding cows at the above mentioned time, some distinct advantages are found. If the cow does not conceive the first time, two other chances come before the calving interval runs past 365 days. It is also observed that cows bred in the earlier heat periods conceive more readily than when a 12-week period elapses. As shown in Table 2, a higher production per day is obtained from cows with a calving interval of less than 365 days, thus giving a higher herd average.

THE EFFECT OF FEEDING SOME FAT SOLUBLE DYES TO MILKING COWS UPON THE COLOR OF MILK FAT

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SECTIONS OF DAIRY HUSBANDRY AND CHEMISTRY

Several investigators have attempted without success to stain butterfat by feeding Sudan III, a red fat-soluble dye to cows. Gage and Fish (1) and Mendel and Daniels (2) failed to stain the milk fat from cows by feeding Sudan III. Recently Kelly and Petersen (3) in studying fat synthesis in the mammary gland also were unable to stain the milk fat by feeding Sudan III with either butterfat or peanut oil. A Jersey cow was fed approximately 27 grams of the dye over a period of 10 days and a Holstein cow received 15 grams over a 9-day period.

In studying the effect of different fats on milk and fat production, the authors were interested in following food fat through the digestive tract and into the milk. Consequently, five different fat-soluble dyes have been fed in this investigation, namely, Sudan III, Sudan IV, Brilliant Green, Perfect Purple and Nigrosine Black. The first two dyes are red. Fifteen grams of dye was fed in one feed in all cases except Nigrosine Black where the dose was 45 grams. The dyes were mixed with 0.5 pound of crude soybean oil with the exception of the Sudan IV which was mixed with solvent-extracted soybean oil meal. The cows used in this study were producing about 0.5 pound of butterfat per day.

The effect of feeding the various dyes is shown in Table 1.

It is apparent that milk fat is readily stained by feeding the fat soluble dyes used in this study. When either Sudan III or Sudan IV were fed the color was noticeable in the next milking, 12 hours later. No doubt the initial appearance of the dye would have been less than 12 hours had the cows been milked more than twice daily. The greatest amount of dye appeared in the milk fat at 24 hours after feeding in case of Sudan III and Sudan IV. The effect of a single feeding of Sudan III persisted in the butterfat in declining amounts for more than 72 hours. Unfortunately later samples were not saved from this animal. The lag persisted for 144 hours after feeding Sudan IV. This is in agreement with the passage of food through the digestive tract as shown by Moore and Winter (4).

When Brilliant Green was fed the resulting butter was white with a green tinge. When the butter was melted, however, the butter oil was stained green. The most intense color appeared at 36 hours with this dye, and the lag was 132 hours.

The feeding of Perfect Purple resulted in the production of a green colored butterfat. There was some effect on the color of the butterfat at 12 hours, although the distinct green coloration was not visible until 24 hours after feeding. The green color was most pronounced in the

Table 1. The effect of feeding 15 grams of various fat-soluble dyes at one feed on the color of butterfat.

Cow	Dye Fed	Hours After Feeding Dye	Color of the Butter
Jersey—No 76	Sudan III	0	yellow
		12	slightly pink
		24	very pink
		36	less pink than at 24 hours
		48	less pink than at 36 hours
		60	pink color much reduced
Holstein—No 289	Sudan IV.	72	some pink color
		0	yellow
		12	slightly pink
		24	pink
		36	slightly less pink
		48	slightly less pink
		60	slightly less pink
		72	less pink than at 60 hours
		84	less pink than at 72 hours
		96	less pink than at 84 hours
Holstein No 199	Brilliant Green	120	slightly pink
		132	less pink than at 120 hours
		144	very little pink
		180	yellow—no pink (Color of the butter oil)
		0	yellow
		12	no green showing
		24	fairly green
Holstein No 269	Perfect Purple	36	green
		60	less green than at 36 hours
		84	less green than at 60 hours
		108	less green than at 84 hours
		132	less green than at 108 hours
		156	no green
		0	yellow
		12	less yellow
		24	green
		36	very green
		48	green, same as at 24 hours
		60	some green
		72	some green
		84	same as at 12 hours
		96	yellow

butterfat at 36 hours. The green color persisted in the fat at diminishing rate for more than 84 hours. Nigrosine Black produced a pink butterfat when fed at 45 gram levels. It is apparent, from these results, that certain dyes are altered either in the digestive tract or in the system of the cow. The possibility of using these fat-soluble dyes in studying the relation of food fat to milk fat is indicated. Either Sudan III or Sudan IV appears to be preferable to the other dyes used in this study.

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THE EFFECT OF VARIOUS GROWTH-PROMOTING CHEMICALS ON THE PRODUCTION OF TOMATO FRUITS IN THE GREENHOUSE

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SECTION OF BOTANY

The observation that pollen contains substances which stimulate the enlargement of the ovary apart from the fertilizing function of the pollen nucleus was made in 1902 by Massart (11) and in 1909 by Fitting (3, 4). For many years this discovery received little attention. In 1918 Morita (12) repeated some of Fitting's experiments and attempted the stimulation of ovary development with several organic chemicals: formic, acetic, butyric, palmitic, and stearic acids, and various sugars.

Then in 1932, Laibach (10) further verified Fitting's work and also found that in animal tissue, particularly liver, there were hormones which would induce development of the plant ovary. In 1934, Yasuda (15) and in 1936, Gustafson (6) produced parthenocarpic fruit with pollen extracts. During the same interval, the chemists had been isolating these growth-promoting substances in a pure state, and found them to be such chemicals as indole-3-acetic acid and related compounds. In 1936, Dollfus (2) showed that developing ovules produced hormones which induced the growth of ovary wall or fruit cup. When he removed the ovules from an enlarging ovary, growth stopped, but when he replaced them with indoleacetic acid in lanolin paste, fruit development continued.

The same year, Gustafson (7) reported the production of parthenocarpic fruits of various kinds, using pure chemicals instead of pollen extracts. Since 1936, several workers have attempted the practical application of this phenomenon. In 1937, Gardner and Marth (5) showed that a 100 per cent set of holly berries could be induced by applying a 0.01 per cent aqueous solution of naphthaleneacetic acid as a spray. This plant is well adapted to such a treatment, being dioecious and having all the flowers in a cluster open at one time. The same year, Schroeder (13) produced parthenocarpic tomato fruit with indoleacetic acid. In the summer of 1938, Wong (14) obtained seedless watermelon and cucumber fruits with naphthaleneacetic acid. In 1939, Howlett (8) described the production of parthenocarpic tomato fruit with indoleacetic and indolebutyric acids, and Burrell and Whitaker (1) recommended the use of indoleacetic acid to increase the development of fruit after making muskmelon crosses.

The work herein reported was undertaken in the spring of 1938 with the idea of increasing the set of fruit in greenhouse tomatoes which usually require some artificial means of insuring pollination such as jarring the vines, or hand pollination. In Michigan, where much

cloudy weather prevails in fall and winter, only a portion of the pollen produced under these conditions is fertile (9), and even with artificial pollination, there is a considerable reduction in number of fruit set. Could the application of growth-promoting chemicals to the ovaries of tomato flowers induce a better set of fruit with no more labor and expenditure than is involved in hand pollination? An answer to this question was sought in experiments.

Experiments with Greenhouse-grown Tomatoes

In the spring of 1938 some preliminary trials were made on John Baer tomato plants under conditions of commercial production in the greenhouse. The plants were set 12 inches apart each way with a 2-foot aisle between every other row. The soil was a good sandy loam on which one tomato crop had been grown previously. Moisture was supplied by ground irrigation. No fertilizer was applied until near the middle of the season when a side dressing of ammonium sulphate was used. The plants were pruned to a single stem, and supported on one-inch vertical wooden stakes.

Pure indolebutyric acid, as well as Hormodin and Auxilin (proprietary compounds containing indolebutyric acid), was mixed with hydrous lanolin to make a paste which was applied to the ovary in various ways. A few trials clearly indicated that the proper time for the application of the treatment is at anthesis or when the corolla is completely reflexed. Application of the hormone at earlier or later stages of flower development is seldom successful in producing fruit. In the first experiments the flowers were emasculated. Later this was found unnecessary. Usually two or three flowers in a cluster were treated chemically. The others were not removed but were hand-pollinated. Experimental flowers were tagged, and careful records kept of fruit production.

In some tests the lanolin paste was placed on the stigma with a small brush or glass rod, and in some the style was cut off with surgeon's scissors about 3 mm. above the ovary and the paste applied on the cut surface. Only one application was used on cut styles and part of the stigmas, while some stigmas received two applications with a five-day interval. The results of these experiments are shown in Table 1.

Although the number of flowers treated was small, the data given in Table 1 indicate that a higher percentage of set as well as larger fruit results when the number of treatments on the stigma is increased, and that cutting the style before treatment greatly increases the effectiveness of a single application. Schroeder (13), using a different chemical, obtained results which pointed to similar conclusions.

The fruits induced by the chemical treatments were of normal color and good flavor, seedless, and contained only small ovules. The fruits were more meaty and heavier in proportion to their size than those produced naturally. Less of the watery gelatinous portion which usually surrounds the seeds was present. Figure 1 shows a photograph of some parthenocarpic fruits in cross-section. If fruits with seed are desired, the hormone may be applied after pollination, and normal fruit of increased size will result.

Some spray treatments with indolebutyric acid in aqueous and alcoholic solutions were also attempted but were not satisfactory. All

Table 1. Effects of three methods of hormone treatment on fruit production of the tomato.

Treatment	Concentration (Percent)	Method of Application	Number of Flowers Treated	Number of Fruit Set	Percentage of Fruit Set	Average Weight of Fruit in Grams
Hormodin	Approx. 0.1	Stigma (1 application)	9	1	11	52
		Stigma (2 applications)	6	4	66	110
		Cut style (1 application)	17	14	82	125
Auxilin	Approx. 0.1	Stigma (1 application)	7	0	0	0
		Stigma (2 applications)	10	7	70	110
		Cut style (1 application)	16	13	81	92
Indolebutyric acid	0.5	Stigma (1 application)	33	8	24	96
		Stigma (2 applications)	9	7	89	152
		Cut style (1 application)	16	14	87	129
Hand pollination			50	42	85	110

the flowers in the inflorescence do not open at the same time, but usually two at a time, at two- or three-day intervals. This flowering habit made several spray applications necessary. The first spray often injured the younger flowers so that they failed to mature, and thus reduced rather than increased production. Injections of water solutions of indolebutyric acid with a fine hypodermic needle into the ovary and into the pedicel of the flower were unsuccessful in stimulating fruit development.

In the fall of 1938 John Baer plants were used to test the value of three different concentrations of four chemicals in the production of parthenocarpic fruit. The plants were set as before in the same soil which was given a light application of complete fertilizer low in nitrogen. Concentrations of 0.1, 0.5, and 1.0 per cent of indoleacetic acid, indolebutyric acid, phenylacetic acid, and naphthaleneacetic acid were tested. All the treated flowers were handled in the same manner. When the corolla was completely reflexed, the central cylinder consisting of the style surrounded by stamens was cut off with sharp scissors, leaving about 3 to 5 mm. of the style and the bases of the filaments still attached (Fig. 2). The chemicals were then applied in a lanolin paste to the cut surface.

This proved to be a quick and easy method of preparing flowers

for treatment, and very effective when the hormone was used in lanolin. The bases of the filaments protected the ovary from injury and helped hold the lanolin paste in place.

All the flowers in a cluster were treated or hand-pollinated as they matured. The number of fruits in a cluster was never reduced by the removal of blossoms. Only one application of the chemical was made in these trials.

Influence of Hormone Treatment on Maturing Season—The treatments were carried on continually for two months as the flowers opened. A few flowers were used for each treatment every week so that the developing fruits would be subjected to comparable light conditions as the days grew shorter.

The more rapid enlargement of treated ovaries in comparison with those hand-pollinated was so noticeable that a record was kept of the length of time required for maturation of the fruits. Some treatments reduced the average time to harvest as much as five days. Results of these tests are shown in Table 2.

Influence of Hormone Treatments on Fruit Size—The average size of fruit produced was smaller than that of the preceding spring crop. Hormone treatment can hardly be expected to supply food materials deficient because of low photosynthetic activity in short day-light, even though it can substitute for sterile pollen. Indolebutyric acid at 0.5 per cent concentration proved to be the most effective chemical tried. This treatment increased the set of fruit 18 per cent above the number resulting from hand pollination and increased the average weight of fruit 26 per cent. It also decreased the average length of time to har-

Table 2. A comparison of the fruit-inducing effects of four chemicals on tomato.

Treatment	Concen- tration (Percent)	Number of Blooms Treated	Number of Fruit Set	Percentage of Fruit Set	Average Weight of Fruit in Grams	Average Time to Harvest Days
Indolebutyric acid	0.1	105	31	29	59	47
	0.5	84	82	98	95	43
	1.0	90	20	22	75	50
Indoleacetic acid	0.1	83	0	0	—	—
	0.5	77	13	18	56	48
	1.0	86	2	02	69	50
Phenylacetic acid	0.1	95	19	20	75	45
	0.5	72	54	75	94	46
	1.0	116	16	13	67	49
Naphthaleneacetic acid	0.1	70	0	0	—	—
	0.5	75	51	66	46	43
	1.0	72	27	37	50	49
Hand-pollinated	—	147	102	70	75	48
Naturally pollinated	—	100	48	48	70	48

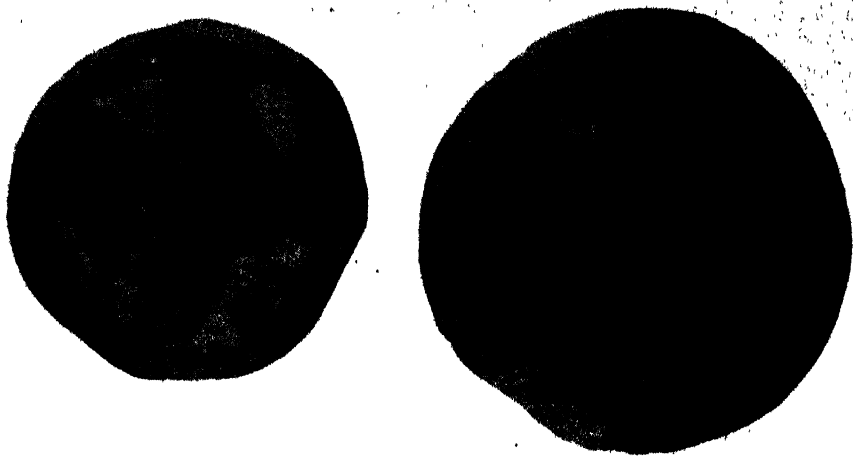


Fig. 1 Parthenocarpic tomato fruits in cross section.

vest by five days. Phenylacetic acid at 0.5 per cent concentrations appeared to be almost as effective in respect to size of fruit produced, but the number set was 23 per cent less than with indolebutyric acid. In general, the results obtained in these tests are comparable with those of Howlett (8) who found indolebutyric acid, even at lower concentrations, produced more and larger fruit than indoleacetic acid.

All possible combinations of twos and threes as well as all four of these chemicals were mixed together in equal parts so that the resulting concentration was 0.5 per cent of chemicals in lanolin and applied to cut styles with varying degrees of success in fruit production. None of the combinations proved so effective as indolebutyric acid alone.

Solvents for Indolebutyric Acid—Because indolebutyric acid is only very slightly soluble in water, a solvent was sought in which this chemical could be used without injury to the flower and which would perhaps act as a penetrant as well. Indolebutyric acid was found to be very soluble in the following commercial solvents: Morpholine,* Trigamine,** Glycocon AA,** Turkelene, ** Prolaurine,** and Diglyceryl laurate. The three last-mentioned chemicals injured plant tissue and could not be used, but the first three were more or less successful as hormone solvents in the production of parthenocarpic fruit.

Trigamine, a borated ester of a polyhydric alcohol amine, is a viscous, nonhygroscopic liquid with an alkaline reaction, nonvolatile below 100° C. Morpholine is also an amine, a mobile liquid, alkaline in reaction, which absorbs water and carbon dioxide from the air to form a carbamate. It is miscible with oils and was used in these tests alone and mixed in equal parts with cottonseed oil. Glycocon AA is a polyhydric alcohol, a mobile, hygroscopic liquid, alkaline in reaction. This

*Product of Carbide and Carbon Chemicals Corporation, New York.

**Manufactured by Glyco Products Company, Inc., New York.

compound was used alone and in equal parts with Aqualube, a viscous, nonhygroscopic, nondrying, noncrystallizing product. None of these solvents, alone and without the addition of the hormone, possessed any ability to induce fruit production.

In the spring of 1939, Marglobe plants were grown in the same greenhouse soil with another light fertilizer application. Spacing and



Fig. 2. Production of parthenocarpic fruit. "A" shows stamens and style of left flower being clipped with scissors. Central flower has already been cut. Flower at right has had several stamens removed to show relationship of flower parts. "B" shows central flower being treated with hormone on glass rod. Flower at left has already been treated.

Table 3. A comparison of various solvents for indolebutyric acid in the production of parthenocarpic tomato fruit.

Solvent	Concentration of Acid	Method of Application	Number of Blooms Treated	Number of Fruit Set	Percentage of Fruit Set	Average Weight of Fruit in Grams	Average Time to Harvest Days
Trigamine	1-10	Cut style	148	115	78	80.8	51
		Stigma	155	119	76	70.8	51
	1-20	Cut style	14	4	28	90.0	47
		Stigma	17	12	70	68.0	48
Morpholine	1-10	Cut style	49	32	65	72.0	48
		Stigma	15	6	40	110.0	44
Morpholine plus cottonseed oil . .	1-20	Cut style	22	6	27	50.0	48
		Stigma	31	16	51	126.6	44
Glycapon AA	1-10	Cut style	48	21	43	81.3	47
		Stigma	23	0	0	—	—
	1-20	Cut style	11	10	99	94.0	48
		Stigma	11	3	27	98.0	48
Glycapon AA plus Aqualube	1-10	Cut style	20	18	95	113.0	54
		Stigma	24	20	83	108.0	54
Hand-pollinated . . . .	. . . .	. . . .	100	75	75	78.0	56
Naturally pollinated . . . .	. . . .	. . . .	120	76	64	77.0	56

handling was the same as in the previous experiments. When the plants came to flowering they were treated with indolebutyric acid in these different solvents both upon the stigma and the cut style. Results are shown in Table 3.

All the fruits produced both naturally and artificially were somewhat smaller than normal for this variety, owing, probably to insufficient fertility of the soil which had supported three previous tomato crops with only light applications of fertilizer.

Indolebutyric acid 1-20 in equal parts of Morpholine and cottonseed oil applied on the stigma induced the largest fruit in the shortest time to harvest. The increase in average weight was 58 per cent above that resulting from hand pollination, but the number set was 32 per cent less. When this acid was used in Trigamine, the average weight of fruit and percentage of set were about the same as were produced by hand pollination although the number of days to harvest was decreased. Indolebutyric acid 1-10 in equal parts of Glycapon AA and Aqualube resulted in a 38 per cent increase in average weight of fruit and a 10 per cent increase in set over hand pollination but did not materially reduce the time to harvest. Indolebutyric acid 1-20 in Glycapon AA applied to the cut style produced the best set (99 per cent), a small increase in average weight of fruit, and a reduction in length of time to harvest.

Malformations—Sometimes the chemically-induced fruits were imperfectly formed (Fig. 3), showing a defect commonly known as "cat-face." Occasionally one locule would not fully develop, producing a

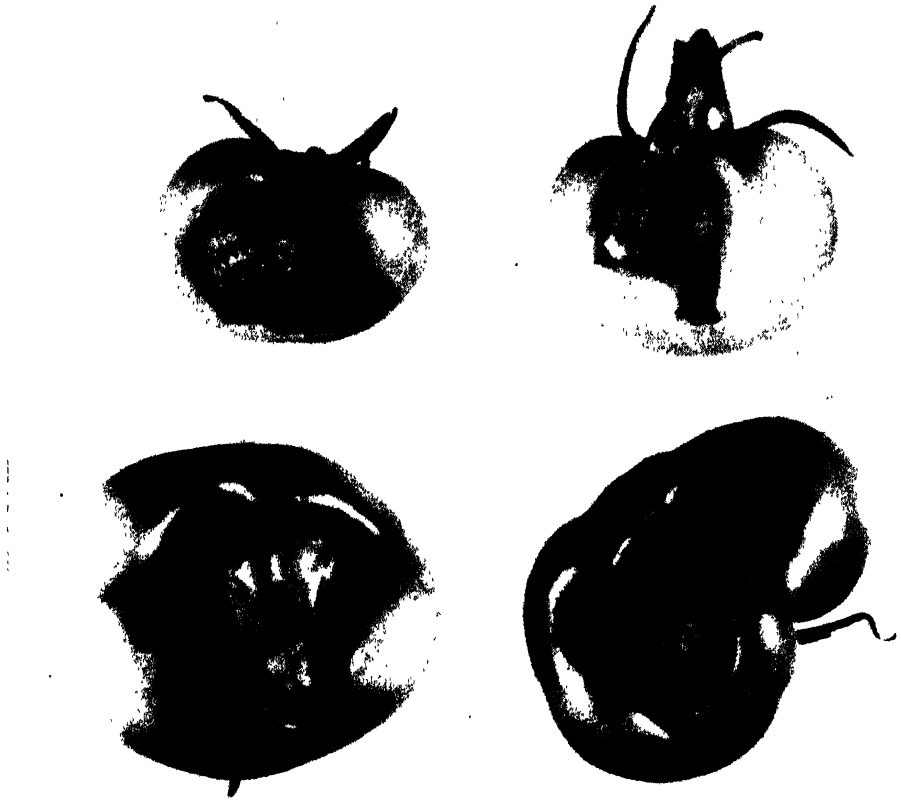


Fig. 3. "Cat-face" of parthenocarpic fruit.

lop-sided effect. The malformations also occur in naturally pollinated fruit and are not peculiar to parthenocarpic fruit alone. Blemishes on the skin often occurred when the lanolin paste or solution was used too liberally. An internal discoloration was observed at times in both parthenocarpic and pollinated fruit, and is believed to be associated with some nutritional unbalance.

A severe infestation of nematodes vitiated the results of a fourth series of experiments undertaken in the fall of 1939, and no opportunity to pursue these studies further has presented itself. Although the work has not been brought to completion, the results obtained warrant publication. While the methods of application so far devised are not entirely satisfactory, the author is of the opinion that the use of growth-inducing chemicals to replace or supplement pollination may be a valuable and practical procedure in increasing the yield of greenhouse tomatoes.

Summary and Conclusions

It has been shown that indolebutyric acid applied to the ovaries of tomatoes in the greenhouse increases the number of fruits set as well

as their average weight above those resulting from hand pollination, and decreases the length of time required for maturation of the fruit.

The work involved in cutting the style with scissors and applying the chemical is not any more difficult or time-consuming than hand pollination, though it is more expensive and time-consuming than jarring, where that method is found satisfactory. The chemicals used are expensive but such a minute amount is sufficient that the expense is almost negligible for each fruit. This treatment may be used to advantage as a substitute for or a supplement to pollination. The author believes that with improved technique for application of the hormone, this method of fruit production will be practical in the hands of growers.

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A FRUIT TREE COATING EFFECTIVE AGAINST COTTONTAILS*

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The bark of certain fruit trees is often injured by cottontail rabbits. In Michigan this game species is protected by law. The use of wire-mesh guards for protecting tree trunks is discussed in Michigan State College Extension Bulletin 196, "Protecting Fruit Trees Against Mice and Rabbits" by T. A. Merrill.

A test of certain coatings as rabbit repellents was reported by J. A. Neilson in 1933.** Of the formulae then recommended, the one receiving widest usage is a mixture of rosin, 5 parts, and linseed oil, 1 part. This mixture requires a portable heater and is impractical at cold temperatures. Neilson warned against its use on peach and sweet cherry bark. Certain users have since reported injury apparently due to this material.

The need for a more practical coating prompted the present authors, in 1937, to renew the tests left unfinished at the death of Neilson. More than 200 materials or mixtures have since been tested as repellents for cottontails. A few of the most promising materials have been further tested for their effect on the growth of young trees.

Methods

The tests of repellent effectiveness were conducted in enclosures, approximately 40 feet square, containing several rabbits. The animals were fed very lightly. The materials to be tested were painted on small tree trunks or cut branches. The severity of these tests is illustrated by the rabbits refusing to eat the bark of treated apple shoots while feeding freely upon sour cherry bark from untreated one-inch trees. It is assumed that under these conditions the repellents affording the best protection should be the most trustworthy in orchards.

The effect of a few of the most promising repellents on the growth of young trees was observed. The planting included about 700 young seedlings of apple, peach, pear, Myrobalan plum, Mazzard and Mahaleb cherry. Certain of the trees were coated annually. Growth measure-

*All tests were made with the Cottontail Rabbit, *Sylvilagus floridanus mearnsii* (Allen). Preliminary repellent tests with the Snoeshoe Hare, *Lepus americanus americanus* Erxleben, and the Meadow Mouse, *Microtus pennsylvanicus pennsylvanicus* (Ord.), indicate that these species are not deterred by those effective cottontail rabbit repellents, which have been tested.

**Michigan Agricultural Experiment Station Quarterly Bulletin 16 (2): 59-62, 1933.



Fig. 1. A view of a portion of the repellent trial pen at Graham Experiment Station near Grand Rapids. This shows the method of testing treatments on young trees as well as on apple shoots fastened to the fence. Note that the cotton-tails have eaten bark from the untreated ends but refused to eat the treated bark of the effective repellents.

ments were taken each fall. Because of the closeness of the planting, the tests were concluded after the second season. It is hoped that future tests may determine the repellency of sprayable dilutions of this and other compounds.

Results

The only repellent that proved to be safe to use on those trees, as well as effective against cottontails, was a formula consisting of rosin and ethyl alcohol.* In these trials the trees treated with the rosin-linseed oil formula showed positive evidence of restricted growth.

*F. C. Bradford, formerly with this institution, now with the U. S. Department of Agriculture, obtained this modified formula from a Michigan fruit grower, whose identity is not known to the authors. In protecting experimental nursery stock he observed injury apparently due to the rosin-linseed oil formula, and substituted the rosin-alcohol formula about 1930.

Preparation and Application

The dark-colored, cheaper grades of rosin and the cheaper grades of denatured commercial ethyl alcohol were found to be as satisfactory as the higher grades. So-called "antifreeze" alcohol may be used if it does not contain methyl alcohol. Methyl alcohol (wood alcohol or methanol) does not dissolve rosin.

A satisfactory coating may be made by dissolving 7 pounds of rosin in a gallon of alcohol. These proportions are slightly more than one part of rosin to one part of alcohol, by weight. A good method of mixing is to pulverize the rosin and add it to the alcohol in a container with a cover tight enough to allow shaking and prevent evaporation. If the container is kept in a warm room, and shaken occasionally, the rosin will dissolve more rapidly. **No heat should be applied.** To heat the solution not only is dangerous but may drive off enough alcohol to alter the composition of the mixture. Handled in this fashion, the rosin is usually dissolved in 24 hours. It is well to mix at one time only as much as will be used in a few days.

Water causes a white precipitate to be formed in this solution. If much of this precipitate is present, it will greatly alter the consistency of the repellent, or even seriously interfere with its application. To avoid contamination of the reserve stock, a smaller container should be used in the orchard. The brush will pick up water from snow or damp soil and carry it into the field container. Therefore the repellent solution should not be poured from the field can back into the reserve stock.

Trees treated with the rosin-alcohol repellent always turn white in the next rain or snow. This does not change the effectiveness of the repellent. Indeed, a white surface reflects sun rays and may minimize winter injury.

The trees should be treated in fall and only when the bark is dry. One application of this repellent protects all winter. It should be ap-



Fig. 2. After a few of the most trustworthy repellents were found they were tested for two years on young trees of apple, pear, peach, plum, and cherry to determine injurious effects on the growth of the trees.

plied to trees with a cheap paint brush. Brushes, containers and gloves may be cleaned with alcohol. Cottontail rabbits can reach about two feet; therefore young trees should be painted two feet higher than the snow is expected to drift. Scaffold limbs of low-branching trees should be treated when they are within the zone of possible rabbit damage.

Field tests show that one gallon of repellent will be sufficient to treat about 150 to 200 two-year-old nursery trees, the exact number depending on the height of treatment and size of tree. One man found that he could coat about 35 four-year-old apple trees in an hour.

A COBALT DEFICIENCY DISEASE OBSERVED IN SOME MICHIGAN DAIRY CATTLE

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SECTIONS OF DAIRY HUSBANDRY, ANIMAL PATHOLOGY AND CHEMISTRY

A disease of dairy cattle colloquially known as "Grand Traverse or Lake Shore Disease" has been recognized in this state for many years. An early account of this condition was reported by the Michigan Agricultural Experiment Station in 1909 (1) in which the disease was characterized by general emaciation, incoordination in gait, depraved appetite, and usually terminated fatally. It was also observed in the majority of cases that recovery took place if the animals were moved from their own districts to higher lands.

Nearly every year since that time it has been the common experience of many dairymen during the winter and early spring months that many cows refused to eat very good alfalfa hay or cereal grain, became emaciated and in some cases died. If the cows were able to survive the general emaciation, the condition was usually alleviated when the animals had access to succulent spring pasture. This situation has been greatly emphasized during the past winter. Numerous instances have been reported where cattle became unthrifty, developed morbid appetites, attained extreme emaciation and finally refused to eat. Cows dropped calves in an apparently normal manner but the calves dwindled and died in from two to six weeks. After calving the condition of the cows declined very rapidly. All of these things occurred despite good feed and good feeding methods. The feed was supplemented by salt and bone meal, and in some cases molasses was added as a safeguard against ketosis.

Conditions of emaciation in cattle and sheep are not confined alone to Michigan but diseases in certain geographical areas, variously known as, "salt sick" in Florida, "neck ail" in Massachusetts, "pine" in Scot-

*The writers have had the benefit of most generous cooperation, comment and suggestions from the county agents and herd owners in the hereinafter named counties. They are especially indebted to Mr. E. DeLong, Northport, for helpful suggestions during the course of the work, and to Mr. F. H. Waterman, Suttons Bay, who, insofar as we were able to ascertain, was the first to feed cobalt to dairy cattle in Michigan.

land, "bush sickness" in New Zealand, "coast disease" in South Australia, and "Nakuritis" in Kenya Colony have been reported. All of these conditions have responded to iron or iron and copper, and in some instances, cobalt therapy.

During the stall-feeding period of 1940-41, an unusually large number of cows and calves (in the upper third of lower Michigan) have been affected. The purpose of the present note is to give a general outline of the work conducted and the conclusions which seems to be justified from the evidence thus far obtained.

Numerous farm visitations were made in the northern counties, Manistee, Leelanau, Antrim, Presque Isle, Alpena and Alcona, bordering Lakes Michigan and Huron to observe the condition and to collect blood, urine and feed samples for chemical analysis. The symptoms of the disease were well defined and consisted of progressive debility, anorexia, a marked decrease or cessation of milk flow, depraved appetite, and general emaciation. The hair had a rough, hard dry appearance and the animals did not shed hair until late in the season. The visible membranes were pale. Many animals not showing acute symptoms appeared to lack thrift. Calves were also subject to this disease and they often succumbed at an early age. Growth was retarded markedly and the calves presented a stunted and unthrifty condition. The skin became scaly and dry and the animals developed a depraved appetite for hair. General ill health became manifest as emaciation progressed. Many of the cows and some calves showed a marked tendency to eat swamp grass, straw, bedding and to gnaw vigorously trees, fence posts and stanchion ties. The disease seemed to be prevalent in cattle of all ages and both sexes were affected.

Despite the feeding of bone meal and molasses in approved quantities in several of the herds under observation, the obvious resemblances of the clinical findings to phosphorus deficiency and also to extreme ketosis prompted us to carry out estimations of plasma inorganic phosphorus and to examine the urine for the presence of ketone bodies. The results of the biochemical data definitely eliminated these two diseases. The hemoglobin values of the severely affected cows suggested the similarity of this condition to that in sheep as reported by the Australian and New Zealand workers (2) in which it was found that one milligram of cobalt per day brought about a remarkable improvement in the condition of the sheep.

After consultation it was decided to set up a field experiment on adjoining farms on which herds were severely emaciated. One herd received 13 milligrams of cobalt per day per cow as cobaltous chloride in addition to the regular home-grown feed, while the adjoining herd served as the control. Within 3 to 10 days following the administration of the cobalt supplement, all of the treated cows showed a spectacular improvement in appetite, milk production and general appearance, while the adjoining herd became progressively worse. These developments occurred in cows which had been afflicted for several months and were in most instances refusing to eat or just nibbling at good feed. Later the control herd received the cobalt supplement with the same phenomenal recovery. In addition to the above-mentioned herds, eight other herds have received a cobalt supplement (as the sulphate or chloride) during the past stall-feeding season, with the

same results. In some instances the herd was divided and part of the animals were used as controls but usually this was not satisfactory because the herd owner soon observed the results in the treated groups and saw no reason for depriving the other cows of the benefit of the treatment. It should be emphasized, however, that the only change in the routine feeding practice in all of the farm herds has been in the addition of the cobalt supplement. With this treatment the same home-grown feeds which produced the deficiency disease were adequate to support normal nutrition and to gradually restore milk flow to its maximum capacity.

Hemoglobin and plasma inorganic phosphorus determinations were made in conjunction with the cobalt feeding trials at irregular intervals. The hemoglobin values of the severely emaciated cows were found to vary between 6 and 8 grams per 100 ml., whereas the hemoglobin values of the mildly affected cows varied from 8 to 10 grams. In nearly all cases the hemoglobin values decreased 10 to 20 per cent following the administration of cobalt before the values turned upward. Hemoglobin regeneration was not so responsive to cobalt supplementation as was desired but the general response of the cows in appetite, appearance and increasing milk production was very satisfactory. Preliminary results from hay samples obtained from affected farms show that they contain from one-third to one-half as much cobalt as did hays from unaffected farms.

In summary, clinical evidence has been obtained which indicates that the "Grand Traverse or Lake Shore Disease" is essentially a condition due to cobalt deficiency. Biochemical investigations have demonstrated a very low concentration of hemoglobin in the blood and no evidence of ketosis or phosphorus deficiency. Hemoglobin regeneration occurred slowly but the animals responded very quickly in appetite and vigor to cobalt supplementation. Preliminary chemical investigations have shown that the cobalt content of hay grown on affected farms is much lower than hay grown on farms in unaffected areas.

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FARM PRODUCTION, DISPOSITION AND INCOME FROM MILK FROM MICHIGAN FARMS, 1924-40

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SECTION OF AGRICULTURAL ECONOMICS

The Bureau of Agricultural Economics of the United States Department of Agriculture has made estimates of the production, disposition, sales and value of dairy products to farmers since 1928. Recently the annual estimates by states from 1924 to 1940 were revised and published.*

Table 1. Number of milk cows, and production of milk on Michigan farms, 1924-40.

Year	Number of milk cows (1)	Production of milk per cow (2)	Total production (2)	
			In terms of milk	In terms of butterfat (3)
	Thousand	Pounds	Million pounds	
1924	823	5,050	4,156	158
1925	810	4,990	4,042	154
1926	775	5,210	4,038	153
1927	755	5,220	3,941	150
1928	751	5,290	3,973	151
1929	760	5,300	4,028	153
1930	778	5,160	4,014	153
1931	811	5,200	4,217	160
1932	842	5,100	4,294	163
1933	868	4,950	4,297	163
1934	880	4,800	4,224	161
1935	860	4,950	4,257	162
1936	862	5,180	4,465	170
1937	868	5,150	4,470	170
1938	877	5,200	4,560	173
1939	886	5,350	4,740	180
1940	903	5,450	4,921	187

- (1) Average number on farms during year, exclusive of heifers that have not freshened
 (2) Excludes milk sucked by calves and milk produced by cows not on farms
 (3) Milk averaged 3.8 percent butterfat

Milk Cows and Production of Milk—The number of cows milked in Michigan in 1940—903,000—was the highest on record (Table 1). Since the low point in the cycle of numbers of dairy cows in 1929, there has been a relatively steady expansion in number of cows milked. The average production per cow of 5,450 pounds in 1940 was also the highest on record. The low prices of dairy products during 1930-35 resulted in a reduction in milk production per cow, inasmuch as farmers decreased their feeding and care of the dairy cows. Improved prices of

*Farm Production, Disposition and Income from Milk, 1924-40, U. S. Department of Agriculture, Mimeographed Report, May 1941.

Table 2. Milk processed into butter and milk utilized on Michigan farms where produced, 1924-40.

Year	Butter churned on farms		Milk utilized on farms where produced			
	Milk used	Butter made	Fed to calves	Consumed in farm household		Total used on farms
				As milk or cream	As farm butter	
		Million lb.	Million lb.	Million lb.		
1924	450	20.4	179	390	284	853
1925	407	18.4	170	382	257	809
1926	376	17.0	170	367	237	774
1927	336	15.2	168	357	208	733
1928	305	13.8	170	352	190	712
1929	274	12.4	173	349	170	692
1930	256	11.6	169	358	163	690
1931	261	11.8	173	388	170	731
1932	307	13.9	172	401	203	776
1933	298	13.5	168	404	199	771
1934	273	12.3	148	393	185	726
1935	252	11.4	145	392	168	705
1936	225	10.2	161	405	150	716
1937	208	9.4	156	402	139	697
1938	192	8.7	160	402	135	697
1939	166	7.5	171	416	120	707
1940	150	6.8	174	419	101	697

dairy products during 1936-40 was accompanied by larger output of milk per cow.

The total production of milk, which is a result of number of cows and production per cow, increased from an annual average of about 4 billion pounds during 1924-30 to almost 5 billion in 1940.

Table 3. Milk sold in farm butter, cream and in whole milk from Michigan farms, 1924-40.

Year	In farm churned butter	In wholesale deliveries		In retail deliveries by farmers(1)	Total utilized in products sold
		As cream	As milk		
Million pounds					
1924	166	1,660	1,215	262	3,303
1925	150	1,646	1,175	262	3,233
1926	139	1,584	1,273	268	3,264
1927	128	1,493	1,312	275	3,208
1928	115	1,431	1,431	284	3,261
1929	104	1,282	1,658	292	3,336
1930	93	1,287	1,654	290	3,324
1931	91	1,484	1,611	300	3,486
1932	104	1,564	1,550	300	3,518
1933	99	1,588	1,536	303	3,526
1934	88	1,557	1,545	308	3,498
1935	84	1,536	1,622	310	3,552
1936	75	1,577	1,782	315	3,749
1937	69	1,512	1,880	312	3,773
1938	57	1,607	1,894	305	3,863
1939	46	1,672	2,025	290	4,033
1940	49	1,470	2,430	275	4,224

(1) Approximations based chiefly on population in small towns and rural areas where most families purchase their milk from local farmers.

Production of Farm Butter—The production of home-made butter, which reached its peak in Michigan at the turn of the century, continued to decline during the period 1924-40—except for a few years during the depression period when prices of butter were high in relation to butterfat, and hard times encouraged self-sufficiency on farms (Table 2). Butter made on farms decreased from over 20 million pounds in 1924 to less than 7 million pounds in 1940. An increasing number of dairy farmers have been purchasing factory butter for home use.

Milk Utilized on Farms—About 4 per cent of the farm production of milk was fed to calves (excluding milk sucked by calves), over 8 per

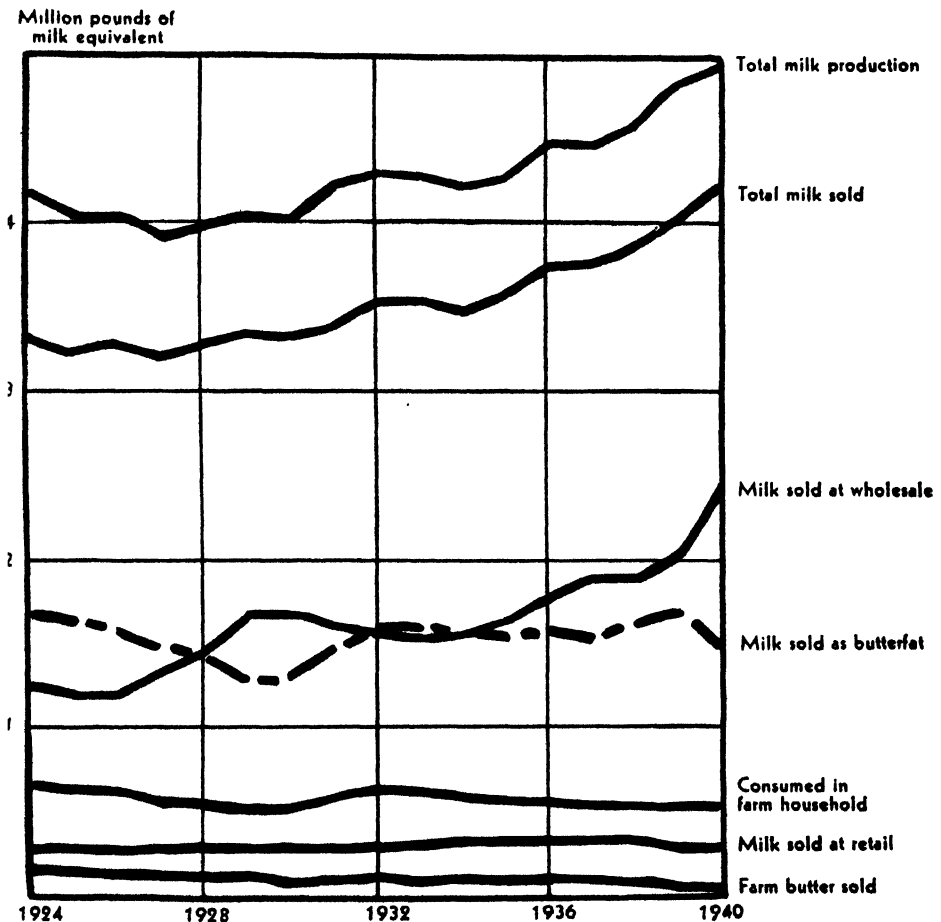


Fig. 1. Milk production and disposition from Michigan farms, 1924-40.

Milk production and sales from farms increased rapidly during 1930-40. The larger output went primarily to the fluid milk markets. The sales of farm butter continued to decline.

cent was consumed in the farm household as milk or cream and over 2 per cent as farm butter in 1940 (Table 2). While the amount consumed as farm butter declined during the period 1924-40, this was partly offset by the expanding consumption of milk and cream by farm families.

Milk Sold by Farmers—The 4.2 billion pounds of milk sold by Michigan farmers in 1940 constituted about 85 per cent of farm production (Table 3 and Fig. 1). The sales of farm butter continued to decline during 1924-40, except during the depression years 1932-33. The milk sold by farmers as cream for factory butter production averaged from 30 to 40 per cent of total milk production during the seventeen-year period. The amount available for butter production has been affected by the requirements for fresh milk and cream, especially during recent years when the demand for the latter has been expanding. The sales of milk in wholesale deliveries increased from 1.2 billion pounds in 1924 to 2.4 billion pounds in 1940. Most of the milk is resold by dealers for direct human consumption as fluid milk and cream. The remainder is utilized in factories for manufacture into cheese, evaporated milk, ice cream and other products.

Table 4. Quantity, price and value of milk sold as farm butter and as butterfat from Michigan farms, 1924-40.

Year	Farm butter sold			Cream sold as butterfat		
	Quantity	Price per lb	Value	Quantity	Price per lb	Value
	(Thous lb)	(Cents)	(Thous dol)	(Thous lb)	(Cents)	(Thous dol)
1924	7,500	42	3,150	60,590	42	25,448
1925	6,800	44	2,992	60,080	43	25,834
1926	6,300	44	2,772	57,820	43	24,863
1927	5,800	47	2,726	54,400	46	25,065
1928	5,200	48	2,496	52,230	47	24,548
1929	4,718	47	2,217	46,790	46	21,523
1930	4,200	38	1,596	46,980	36	16,913
1931	4,100	28	1,148	54,170	26	14,084
1932	4,700	21	987	57,090	18	10,276
1933	4,500	21	945	57,960	20	11,592
1934	4,000	25	1,000	56,830	24	13,639
1935	3,800	29	1,102	56,060	29	16,257
1936	3,400	33	1,122	57,560	33	18,905
1937	3,100	35	1,085	55,190	35	19,316
1938	2,600	29	754	58,660	28	16,425
1939	2,100	26	546	61,030	25	15,258
1940	2,200	30	660	53,660	30	16,098

Farmers retailed from 5 to 7 per cent of their milk production during 1924-40. The low farm prices during 1930-36 encouraged some expansion of direct sales of milk and cream by farmers at the relatively higher retail prices. Higher wholesale prices in 1940 tended to curtail this method of disposal of dairy products. The retailing of milk and cream by producers is limited primarily to small towns and rural areas, where pasteurization is not required.

Farm Value of Dairy Products—Michigan farmers received from 40 to 78 million dollars annually for their dairy products during 1924-40

Table 5. Quantity, price and value of milk sold at wholesale and of milk and cream sold at retail from Michigan farms, 1924-40.

Year	Milk sold to plants, dealers, etc at wholesale			Milk and cream retailed by farmers		
	Quantity	Price per 100 lb	Value	Quantity Milk equivalent	Price per qt.	Value
	(Mil lb)	(Dollars)	(Thous dol)	(Mil qt)	(Cents)	(Thous dol)
1924	1,215	2 15	26,122	122	10 1	12,322
1925	1,175	2 25	26,438	122	10 3	12,566
1926	1,273	2 30	29,270	125	10 6	13,250
1927	1,312	2 35	30,832	128	10 4	13,312
1928	1,431	2 35	33,628	132	10 6	13,992
1929	1,658	2 40	39,792	136	10 6	14,416
1930	1,654	2 10	34,734	135	10 4	14,040
1931	1,611	1 55	24,970	140	9 3	13,020
1932	1,550	1 10	17,050	140	8 2	11,480
1933	1,536	1 15	17,664	141	7 7	10,857
1934	1,545	1 45	22,402	143	8 5	12,166
1935	1,622	1 60	25,952	144	8 9	12,834
1936	1,782	1 80	32,076	147	9 5	13,923
1937	1,880	1 95	36,660	145	9 9	14,366
1938	1,894	1 65	31,251	142	9 5	13,477
1939	2,025	1 65	33,412	135	9 5	12,814
1940	2,430	1 80	43,740	128	9 5	12,160

Table 6. Average farm prices. Cash farm income, value of products consumed in farm household where produced, and gross farm income from dairy products in Michigan, 1924-40.

Year	Average farm prices of butter, cream and milk		Cash farm income from butter, cream and milk (1)	Value of milk products consumed in household on farms where produced	Gross farm income from dairy products (2)
	Per 100 lb milk	Per lb butterfat			
	(Dollars)	(Cents)			
1924	2 03	53	67,042	13,682	80,724
1925	2 10	55	67,830	13,419	81,249
1926	2 15	57	70,161	12,086	83,150
1927	2 24	59	71,035	12,656	84,591
1928	2 29	60	74,664	12,412	87,076
1929	2 34	62	77,948	12,145	90,093
1930	2 02	53	67,283	10,524	77,807
1931	1 53	40	53,222	8,537	61,759
1932	1 13	30	39,793	6,825	46,618
1933	1 16	31	41,058	6,995	48,053
1934	1 41	37	49,207	8,265	57,472
1935	1 58	42	56,145	8,825	64,970
1936	1 76	46	66,116	9,634	75,750
1937	1 89	50	71,427	10,108	81,535
1938	1 60	42	61,907	8,493	70,400
1939	1 54	41	62,030	8,254	70,284
1940	1 72	45	72,658	8,944	81,602

(1) Average farm prices multiplied by amount of milk sold, Table 3

(2) Cash farm income plus value of products consumed in farm household

(Tables 4-6). In addition, the value of dairy products consumed in farm households on farms where produced ranged from 7 to 13 million dollars annually during the period. The lower prices of dairy products since 1929 has been the reason for the lower income to producers. Farm prices of milk and butterfat were only about one-half as high in 1932 as in 1929, and only three-fourths as high in 1940 as in 1929. The prices at retail declined less than the wholesale prices of dairy products. The value of retail sales was 67 per cent of the value of wholesale sales in 1932, but only 28 per cent in 1940.

BULLETIN REVIEWS

Spec. Bul. 307—Michigan Trappers—Hayne, D. W.—The value of Michigan fur crop is comparable with that of certain minor crops. The larger part of the fur comes from the southern agricultural portion of the state. Farm men and boys make up a majority of the trappers. Farmers control the future of the trapping resources of the state, both as trappers and as owners of trapping lands. During the season of 1937-38 trappers were, on the average, about 32 years old, with younger men predominating in numbers. Almost half of the licensed trappers were farmers, with skilled and unskilled labor constituting almost all of the remainder. Age or occupation of the trapper or region of the state where trapping was done seemed to have little influence on the average trapping income. (34 pp., 10 tables, 6 figs.)

Spec. Bul. 308—Refrigerator Cars as Farm Storages—Cardinell, H. A.—This bulletin explains how refrigerator cars no longer useful as rolling stock may be converted into air-cooled or artificially refrigerated farm storages for fruits and vegetables. Methods of managing them are also explained. (38 pp., 10 tables, 13 figs.)

Tech. Bul. 177—Studies in Brucellosis—Huddleson, I. F., Ardrey, W. B., Pennell, R. B., Stahl, W. H., Hamann, E. E. and Munger, M.—A series of 9 short papers, entitled as follows: (1) A study of factors influencing the isolation, cultivation and differentiation of the species of *Brucella*. (2) The presence of a capsule on *Brucella* cells. (3) Study of cross skin sensitization between *Pasteurella tularensis* and *Brucella melitensis*. (4) The immunizing value of the gluco-lipid antigen from *Brucella* cells. (5) Conditions for maximum precipitation and agglutination of antibody in various *Brucella* antiserums. (6) The presence of *Brucella* antibody in the urine of human beings. (7) Separation and study of the lipid fraction of *Brucella abortus*. (8) A study of the leucocytic picture in Brucellosis. (9) A study of the effect of the toxic fraction from *Brucella* cells on the leucocytic picture in normal guinea pigs. (55 pp., 27 tables)

JOURNAL ARTICLE ABSTRACTS

Some Observations on Canine Nephritis—Sholl, L. B., Langham, R. F. and Thorp, W. T. S.—*Jour. Am. Vet. Med. Assoc.* 98: 295-300. 1941. [Journal Article No. 395 (n. s.) from the Michigan Agricultural Experiment Station.]—The authors discuss the clinical histories, autopsy findings and histopathology of 11 cases of nephritis in dogs and tabulate the blood cytological and chemical values of 16 cases. Urine examinations are also discussed. All cases were diagnosed by laboratory exam-

inations. Symptoms alone are not definite enough to make diagnosis. Blood glucose values were high in some cases. Creatinine values were of value in judging kidney impairment. Associated with high creatinine values were high values for non-protein nitrogen and urea. Presence of albumin and casts in the urine are of value in diagnosis. The histopathology is discussed and 8 illustrations are presented to illustrate the kidney lesions observed.

The Genus *Ectacephala* in North America (Diptera, Chloropidae)—Sabrosky, C. W.—Proc. Ent. Soc. Washington, 43 (4): 75-80. 1941. [Journal Article No. 425 (n. s.) from the Michigan Agricultural Experiment Station.]—A brief synopsis of one of the less common genera of two-winged flies, with a key to four species, notes on their distribution, and the description of one species new to science.

Some Observations on Nephritis in Horses—Langham, R. and Hallman, E. T.—Amer. Jour. Vet. Res. 1 (1): 49-52. 1940. [Journal Article No. 426 (n. s.) from the Michigan Agricultural Experiment Station.]—The paper is based on a study of the kidneys of 38 horses ranging in age from 7 to 27, with an average of 16½ years. Six of the animals had been on serum production and were hyper-immunized against types 1 and 2 *Pneumococcus* and diphtheria toxin.

Thirty of the animals were aged individuals. Microscopically, 8 of the cases showed some degree of nephritis, usually focal in distribution and interstitial in type. Twenty-three of the animals showed vascular lesions of the interlobular kidney arteries, usually intimal thickening and sclerosis, occasionally medial degeneration.

Determination of Small Amounts of Zinc in Plant Materials, a Photometric Dithizone Method—Cowling, H. and Miller, E. J.—Ind. and Eng. Chem. (Analytical Ed.) 13: 145-149. 1941. [Journal Article No. 450 (n. s.) from the Michigan Agricultural Experiment Station.]—A photometric, "mixed-color" dithizone method has been developed for the determination of zinc in plant materials in which sodium diethyldithiocarbamate is used to eliminate the interference of other metals which form colored complexes with dithizone. It was found that "carbamate" causes an appreciable reduction in the color intensity of all the dithizone extract, but, by keeping conditions constant in all extractions, a reproducible relationship is obtainable between the color intensity of the dithizone extract as measured with a photometric colorimeter and the amount of zinc present.

Tests involving the determination of zinc in the presence of other metals which form dithizone complexes, the recovery of added zinc from various plant materials, and the agreement between duplicate determinations proved the method to be accurate and remarkably free of interferences.

A one-color method for the determination of zinc was tested and found to be inferior to the mixed-color method.

The light transmission curve of zinc dithizonate in carbon tetrachloride was determined with a spectrophotometer. This curve is discussed in relation to filter selection for the photometric determination of zinc with dithizone.

A Method of Handling Ratios by the Analysis of Variance—Baten, W. D. and Henderson, E. W.—Poultry Science. 20: 227-231. 1941. [Journal Article No. 463 (n. s.) from the Michigan Agricultural Experiment Station.]—This article shows how to handle statistical ratios of whole numbers such as hatchability data, mortality ratios, percentages of fertile eggs, etc., by the use of the analyses of variances. Often such percentages cannot be analyzed by the analysis of variances because of the relation between the means and variances; by transforming the data to angles expressed in degrees they can be so analyzed. This article gives the details for transforming ratios to angles and the necessary procedure in the statistical analysis.

Bartlett's test for homogeneity among variances is presented to show when certain sums of square can be pooled to form an experimental error.

Two examples are given to illustrate the processes.

Time of Ovulation in Cattle—Brewster, J. E. and Cole, C. L.—Jour. of Dairy Science. 24 (2): 111-115. 1941. [Journal Article No. 470 (n. s.) from the Michigan Agricultural Experiment Station.]—Seventy-three examinations were made on 47 cows; 70 ovulations were observed. Fifty-three of these 70 ovulations are included in computing averages. Nine of the cows that were examined were slaughtered to verify the observations of the ovaries. In each case, the ovaries were found to be exactly as predicted. Ovulation was found to occur within the first day after the end of estrous. It varied from 0 hours to 26 hours. The average time of ovulation was $13.57 \pm .68$ hours after the end of estrous. 88.68 per cent of the ovulation occurred between 6 and 19 hours after the end of heat and 67 per cent occurred between 8 and 16 hours after the end of estrous.

Of the 53 ovulations reported, five were dairy cows, 13 Shorthorns, 15 Angus and 20 Herefords. There was no significant difference between the various breeds. The greatest difference found was in the time of ovulation between cows that had calved and heifers that had not calved. There were 16 ovulations among yearling and two-year-old heifers. They ovulated on an average of $11.44 \pm .99$ hours after the end of estrous. Thirty-seven cows ovulated an average of $14.48 \pm .84$ hours after estrous. This was a difference of 3.04 hours between the time required for cows and heifers.

The Minerals in Poultry Nutrition—A Review—Schaible, P. J.—Poultry Science. 22: 278-287. 1941. [Journal Article No. 473 (n. s.) from the Michigan Agricultural Experiment Station.]—Ordinary Feedstuffs, when blended together judiciously to meet requirements for other nutrients, usually supply adequate amounts of most minerals to satisfy the needs of poultry. Calcium, sodium and manganese and, in some regions, iodine, are elements most commonly lacking in sufficient amounts in combinations of plant and animal products. Occasionally, in certain localities or when unusual feedstuffs are used, complex mineral supplements may be necessary but, if so, they should be purchased on a basis of feeding, rather than therapeutic, value. Caution should be exercised to prevent the inclusion in the ration of abnormal amounts of phosphorus, magnesium, iron, selenium, beryllium and sulphur. Grit should be supplied to poultry.

Progress Made in the Study of Brucellosis During the Past Twenty-five Years—Huddleson, I. F.—*Jour. Am. Vet. Med. Assoc.* 98 (768): 181-188. 1941. [Journal Article No. 478 (n. s.) from the Michigan Agricultural Experiment Station.]—This article discusses some of the important contributions that have been made toward clarifying the brucellosis problem in animals and man during the past 25 years. It points out that real progress has been made in the study of this major disease problem. The author has attempted to show that human brucellosis is a preventable disease and that if our existing knowledge is used to the fullest extent, human brucellosis will soon become a disease of the past.

The Freezing and Thawing of Milk Homogenized at Various Pressures—Trout, G. M.—*Jour. Dairy Science.* 24 (4): 277-287. 1941. [Journal Article No. 479 (n. s.) from the Michigan Agricultural Experiment Station.]—Analyses of various portions of milk homogenized at different pressures and frozen partially or wholly have been made.

When creaming was inhibited by heating or by homogenization the unfrozen portion was relatively richer in fat and solids-not-fat than the frozen portion. When creaming occurred, as in the unhomogenized milk, the frozen portion was higher in fat but lower in solids-not-fat than the unfrozen portion.

The titratable acidity of the unfrozen portion was higher than the frozen portion regardless of creaming. No evidence of creaming was noted in frozen homogenized milk but rather a pronounced settling of the fat which was influenced by the rate of thawing. However, creaming occurred to some extent when milk heated to inhibit creaming was frozen.

Frozen homogenized milk upon thawing exhibited no flakiness which was commonly observed when unhomogenized milk was frozen and thawed, but did exhibit a watery appearance at the surface layers which was more pronounced when the frozen milk was thawed slowly.

Marked settling of the solids of milk was noted when homogenized milk was frozen and then thawed. The rate of thawing had a pronounced influence upon the extent of settling of the fat and solids-not-fat; the lower 15 per cent of creaming cylinders of slowly thawed frozen homogenized milk contained as high as 7.7 per cent fat and 24.60 per cent total solids as contrasted to 2.0 and 5.50 per cent respectively of the upper 15 per cent layer. The titratable acidity of the upper and lower 15 per cent portions ranged from 0.04 to 0.35 per cent. Similar trends were observed upon freezing and thawing of skimmed milk.

The drainage of solids from homogenized milk was slightly faster after the first 100 ml. than that of the unhomogenized milk.

Simplification of the Petering-Wolman-Hibbard Method for Determination of Chlorophyll and Carotene—Petering, H. G., Benne, E. J. and Morgal, P. W.—*Ind. and Eng. Chem. (Anal. Ed.)* 13: 236. 1941. [Journal Article No. 482 (n. s.) from the Michigan Agricultural Experiment Station.]—A simplification of the Petering-Wolman-Hibbard method for the determination of chlorophyll and carotene is presented. Instead of adding the solid barium hydroxide octahydrate reagent to the aqueous-acetone extract, a saturated solution of barium hydroxide

is added to the pure acetone extracts in suitable amount to remove all of the chlorophyll, and this mixture is then treated as directed in the original procedure. This technique eliminates the necessity of preparing an active solid reagent from anhydrous barium hydroxide, of having to handle finely divided barium hydroxide octahydrate, or of keeping the solid reagent free from carbonate. During the preparation of the solution the carbonate is removed because of its insolubility, and the addition of dissolved barium hydroxide to the acetone extract produces a very finely divided precipitate of barium hydroxide octahydrate which is extremely active. Detailed directions are given for carrying out the procedure.

Rate of Spermatozoa Travel in Cattle—Brewster, J. E., May, R. and Cole, C. L.—Proc. Am. Soc. An. Prod. December 1940. pp. 304-310. [Journal Article No. 484 (n. s.) from the Michigan Agricultural Experiment Station.]—Twenty-three cows and heifers of different ages and breeds were artificially inseminated and slaughtered after varying periods of time. The genital tract was removed, sectioned, washed with 0.9 per cent saline solution and examined for spermatozoa to ascertain the distance traveled.

Rate of sperm travel in cows that had calved was not influenced by age or stage of estrous. In heifers, which had never calved, however, sperm travel was more rapid during heat. Disease abnormalities producing excess mucus interfered greatly with sperm travel. Occurrence of uterine contractions was not noted. Rate of sperm travel in heifers averaged 1.36 millimeters per minute, in cows 1.6 millimeters per minute. The genital tracts of cows from the external os to the upper end of the Fallopian tubes averaged 64.95 ± 2.27 centimeters and of the heifers 52.70 ± 2.13 centimeters in length. The minimum time required for sperm to reach the distal portion of the Fallopian tube was $5\frac{1}{2}$ hours in mature cows and $4\frac{1}{4}$ hours in heifers. The time required for sperm to reach the infundibulum in mature cows will range from 6 to 9 hours and in heifers from 4 to 7 hours.

The Root System of Red Pine Saplings—Day, M. W.—Jour. Forestry. 39: 468-472. 1941. [Journal Article No. 485 (n. s.) from the Michigan Agricultural Experiment Station.]—The root systems of five red pine saplings were studied. The trees varied in height from 5.3 to 11.0 feet and in age from 12 to 14 years. The root systems were found to consist of a well-developed lateral system with both ascending and descending branch roots which often assumed major importance. Lateral roots varied in length between 10.3 and 18.3 feet, while the maximum extension of vertical roots varied between 1.6 and 6.2 feet. The trees growing in the lighter soil and in the drier situations had developed more extensive root systems with more deeply descending sinker roots.

Five Years' Results in Individual Limited and Full-feeding of Growing and Fattening Calves—Branaman, G. A., Brown G. A. and Propp, G. J.—Am. Soc. An. Prod. Proc. 33: 105-108. 1940. [Journal Article No. 487 (n. s.) from the Michigan Agricultural Experiment Station.]—In the production of choice grade slaughter yearling cattle, either of two methods may be followed, at similar average cost per pound of

finished cattle. Full-feeding on grain practically from birth will produce choice cattle at about 13 months of age, and weighing 730 pounds. If no grain is fed until weaned at seven months of age, and a limited feed of grain is then provided along with a full-feed of corn silage, protein supplement, and hay, choice finish should result at an age of 16 months and a weight of 820 pounds. The limited-fed cattle require less total grain, but much more silage and slightly more hay.

Chromosome Numbers of Some Species and Varieties of *Vaccinium* and Related Genera—Newcomer, E. H.—Amer. Soc. Hort. Sci. Proc. 38: 468-470. 1940. (1941.) [Journal Article No. 496 (n.s.) from the Michigan Agricultural Experiment Station.]—The chromosome numbers of 13 varieties of *Vaccinium corymbosum*, 5 selections of *V. pennsylvanicum*, 5 species of *Vaccinium* and 3 related genera are given, with data on chromosome behavior at meiotic metaphase. The chromosome number of the variety of *V. atrococcum* used in this study was 24 pairs and not 12, as previously reported.

Neither aneuploidy nor any structural chromosome aberrations could be correlated with the varietal differences within species. Chromosome pairing in *V. corymbosum* suggests an autopolyploid origin and the analysis of hybrids between *V. corymbosum* and other species of the genus indicates a recent common origin.

The suggestion is made that hybridization be attempted on a wider range than has been currently practiced.

A Colchicine-induced Homozygous Tomato Obtained through Doubling Clonal Haploids—Newcomer, E. H.—Amer. Soc. Hort. Sci. Proc. 38: 610-612. 1940. (1941.) [Journal Article No. 497 (n.s.) from the Michigan Agricultural Experiment Station.]—Cuttings from cytologically determined haploid plants were rooted and subsequently treated with a 0.4 per cent solution of colchicine. The chromosome complement of two of the 20 plants treated were doubled to produce normal diploid and homozygous tomatoes. No new observations were made on the cytology of the haploid.

Nomographic Charts for the Rapid Computation of Measurement Ratios of Horticultural Products—Barrons, K. C.—Am. Soc. Hort. Sci. Proc. 38: 589-592. 1940. (1941.) [Journal Article No. 498 (n.s.) from the Michigan Agricultural Experiment Station.]—Charts were prepared for the direct computation of shape index in tomatoes and cabbage, (i.e., ratio of polar to equatorial diameter), and also a chart of similar design for the direct computation of the ratio of petiole to entire leaf length in celery. Measurements are made with calipers and by the use of these charts a direct ratio value is obtained without computation.

Directions for the construction of the charts are given and illustrations indicate the manner in which they are used. They could be easily adapted for the computation of measurement ratios of other horticultural products.

The Effect of Triploid Seedling Stocks on the Growth and Yield of Certain Jonathan Apple Trees—Hewetson, F. N.—Proc. Am. Soc. for Hort. Sci. 38: 341-344. 1940. (1941.) [Journal Article No. 505 (n.s.) from the Michigan Agricultural Experiment Station.]—Five-year-old Jonathan apple trees budded on seedlings from the triploid variety

Baldwin were significantly smaller and yielded less than Jonathan trees budded on seedlings from the diploid varieties Jonathan, Northern Spy and Yellow Bellflower. There was no statistically significant difference in growth and yield between trees on diploid seedlings which were large and those which were small at the time of planting. The size of fruit on large and small trees on diploid seedlings averaged 0.24 and 0.21 pound respectively, while those on triploid seedlings averaged only 0.14 pound.

Field Spraying for Control of Grapeberry Moth—Hutson, R.—*Jour. Econ. Entom.* 34 (1): 102-105. 1941. [Journal Article No. 509 (n. s.) from the Michigan Agricultural Experiment Station.]—A recountal of studies upon control of grapeberry moth by spraying during the season of 1939-1940.

Sprays of arsenicals, cuprous cyanide and organic insect poisons, such as nicotine compounds, were applied in replicated plots, alone and in combination. The principal points established were:

1. Calcium arsenate is equal to lead arsenate for grapeberry moth control.
2. Nicotine combinations give equal control with arsenicals.
3. The first post blossom spray is the most important single spray for control of grapeberry moth.
4. A spreader is necessary in the first post blossom spray.
5. Summer oil is the best spreader available for use in the first post-bloom spray. Rosin fish oil soap and sodium-lauryl-sulphate are almost as good as oil in the first post-bloom spray and are superior to late nicotine sprays.
6. A split schedule of two pre-blossom and one post-blossom spray of arsenical followed by at least two sprays of fixed nicotine (Black Leaf 155, 14 per cent) controls grapeberry moth and leafhopper.
7. Certain proprietary copper sprays held disease in check when used with the fixed nicotines without markedly lowering the efficiency of the insecticide.

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 Vol. 23, No. 4, May 1941
 *Vol. 24, No. 1, August 1941

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FROM MINERALS TO VITAMINS

THE STORY OF A CHANGE IN EMPHASIS IN CATTLE FEEDING

With each passing year it appears to the dairyman and livestock producer that his troubles are multiplying. Old disorders spread or become more acute. New ones appear, as if from nowhere. Prices of feeds or other supplies that must be purchased seem mostly to go up. Prices of the finished products that are offered for sale seem mostly to go down. It certainly isn't becoming any easier to obtain a profit from the dairy or livestock enterprise and often it seems to be more difficult. Such, anyway, are the impressions that may be gained from talking with almost any producer. Perhaps they are due, at least in part, to the fact that the happenings and conditions of the present are fresher and in sharper focus than those of a decade or generation ago. In the worry and disturbance caused by something new, or apparently new, we are likely to forget some of the lessons taught by the difficulties and experiences of the past.

Emphasis that is now being placed on the importance of nutrition to the general welfare—including such questions as “adequate” and “balanced” diets, vitamin-deficient and vitamin-reinforced foods, mineral and vitamin concentrates, and finally the role of the farmer in connection with all these products—makes it appropriate to recount briefly the story of a series of studies begun over two decades ago at the Michigan Agricultural Experiment Station and dealing with certain problems confronting the dairy industry.

Some Early Objectives in Feeding Mineral Supplements—Previous to and at the time this series of studies was begun at the Michigan Experiment Station in the early “twenties,” dairymen and other livestock raisers had been experiencing considerable difficulty with abortion, retained placentae, and weak calves. Linseed meal was being rather generally fed as a protein supplement, though it was relatively expensive as compared with certain other high-protein feeds, such as cottonseed meal. There was an almost universal prejudice against this latter material because of its supposed constipating influence and the alleged toxic properties of one of its constituents—gossypol. The bulk of the ration, of course, consisted of home-grown roughage, often poor-grade hay, wheat straw or other relatively low-grade materials. Many attributed the abortion and associated disorders to a deficiency of certain minerals, especially calcium, in the ration and then sought to counteract the deficiency by feeding costly mineral supplements. So general had this practice become that literally hundreds of thou-

sands of dollars were being spent annually by Michigan producers for various commercial mineral preparations that were added to the regular rations, although even with such supplements the disorders which they were supposed to alleviate often continued.

It was at this point or under these conditions that the Michigan Station outlined a program of research designed to throw more light on the mineral content of the feeds that cattle were getting and on their requirements for normal growth, reproduction and the production of milk (Reed, O. E. and Huffman, C. F.—*Mich. Agr. Exp. Sta. Tech. Bul.* 105. 1930). This investigation soon established the fact that, on the whole, the feeds that were being fed were not deficient in such essential minerals as calcium, magnesium and iron; particularly was this true when good quality roughage, such as well-grown and well-cured timothy hay, was fed in liberal amounts (Huffman, C. F., Robinson, C. S. and Winter, D. B.—*Jour. Dairy Sci.* 13: 432-448. 1930). This led to the surmise that perhaps the prejudice against cottonseed meal was likewise ill-founded and that the abortions, retained placentae and associated disorders might be due to some constituent or constituents that the poor hay or roughage carries that the good timothy does not possess—or, on the other hand, to some constituent or constituents that the good timothy hay carries but that are not found in poor quality roughage. This idea was at least partly confirmed when livestock that was fed no cottonseed meal but whose roughage consisted of wheat straw, cottonseed hulls or coarse poor quality hay developed those symptoms (Reed, O. E., Huffman, C. F. and Addington, L. H.—*Jour. Dairy Sci.* 11: 488-515. 1928). It was further confirmed by trials in which as much as 18 pounds of cottonseed meal was fed per day without any ill effects, when accompanied by good quality roughage (Huffman, C. F. and Moore, L. A.—*Jour. Dairy Sci.* 12: 410-418. 1929; also, Huffman, C. F. and Moore, L. A.—*Jour. Dairy Sci.* 13: 478-494. 1930).

Incidentally, the results of these same studies thoroughly discounted the rather generally held opinion that relatively great bulk is necessary in the dairy ration and that constipation and other digestive disturbances are almost invariably associated with concentrated rations (Moore, L. A., Huffman, C. F. and Plum, M. M.—*Jour. Agr. Res.* 44 (10): 789-796. 1932).

The Immediate Cause of Blindness Associated with Improper Rations—That poor reproduction, general weakness and convulsions should result from feeding unbalanced or deficient rations did not seem unreasonable or difficult to understand. Indeed, such results might be expected. How or why a nutrient deficiency should lead to blindness, which was encountered in some of the experimental studies and apparently was to be attributed to toxic or deficient rations, however, was more puzzling. In the early "thirties" Moore and some of his associates gave special attention to this question. With the aid of the ophthalmoscope as well as of many dissections, they discovered that in animals restricted to low-grade roughage, there was a constriction of the canal in the bony structure between eye and brain. This resulted in pressure on the optic nerve sufficient to cause it to cease functioning (Moore, L. A., Huffman, C. F. and Duncan, C. W.—*Jour. Nutrition.* 9 (5): 533-551. 1935; also Moore, L. A.—*Jour. Nutrition.* 17 (5): 443-

449. 1939). No similar constriction developed in the bone openings through which the optic nerves passed of the animals fed high-grade roughage.

Later studies have shown that these same nutrient deficiency symptoms are associated with increased cerebro-spinal fluid pressure (Moore, L. A. and Sykes, J. F.—*Am. Jour. Physiol.* 130 (4): 484-489. 1940).

A Change in Objectives in Feeding Experiments—In view of those findings, the problem then became one of trying to discover what it is in low-grade roughage that brings on, or what is in high-grade roughage that prevents, general weakness, poor reproduction, blindness and associated symptoms. Possibility of its being an excess or a deficiency of certain mineral constituents had been largely eliminated in the earlier feeding experiments with mineral supplements. That it was any one of the major organic food substances—carbohydrates, proteins, oils—did not seem probable, for these could be, indeed had been, altered more or less at will through the feeding of different amounts of various concentrates such as cottonseed meal. Attention was therefore directed toward a study of some of the minor, though perhaps very important, organic constituents.

The many details of the procedures employed to isolate and identify these constituents, to determine the amounts that are found in good and poor roughage of different kinds, and then through feeding trials under controlled conditions to study their influence on general health, condition and performance of animals, need not be recounted here. They may be summarized, however, in the statement that carotene, the precursor or parent material of Vitamin A, was established as the constituent mainly responsible for the very striking difference in influence of good and of poor roughage on the animals. This was first brought out in 1939 (Moore, L. A.—*Jour. Nutrition.* 17 (5): 443-459. 1939; also, Snyder, W. W. and Moore, L. A.—*Jour. Dairy Sci.* 23 (5): 363-371. 1940).

The Carotene Content of Roughage and Carotene Requirement of the Dairy Cow—The portion of roughage that is digestible has long been recognized as varying greatly with kind and likewise stage of maturity at which the plant is cut and methods of curing. Carotene content, however, shows a much greater variation. It may be as high as 400 or 500 parts per million (one-twentieth of one per cent) in dried herbage cut while very young and tender, from 100 to 200 parts per million (one-hundredth of one per cent) in freshly cut herbage at the blossoming stage, from 20 to 40 parts per million in well-cured hay, and as low as only 4 or 5 parts per million (one-two thousandth of one per cent) in low-grade roughage. The extremes given here represent a difference of 100 to 1 and mean that from the standpoint of this important food constituent, a pound of good quality freshly cut hay may be the equivalent of 50 to 100 pounds of wheat straw or 25 to 50 pounds of overripe coarse timothy hay. Expressed in different terms, the cow that would normally require 10 pounds of good roughage to obtain a day's supply of carotene would have to consume and digest 75 to 150 pounds of very low-grade roughage to obtain the same supply—an obvious impossibility.

A 1,000-pound cow normally consumes from 35 to 40 pounds of feed per day, of which at least 25 to 30 pounds will consist of roughage. The studies at the Michigan Station indicate that in order to maintain good health and avoid reproductive difficulties, the day's ration should provide a minimum of 50,000 micrograms (50 milligrams or 1/20 of a gram, slightly less than 1/500 of an ounce) of carotene. If high Vitamin A content milk is to be produced, the ration should contain several times that amount. A normal ration of high-grade roughage provides those quantities, with a margin of safety, even after allowing for a gradual loss in carotene content upon storage for many months in mow, stack or silo. A large ration of low-grade roughage does not provide them.

The Feeding Problem Focuses on Roughages—An important result of this series of studies has been to divert some of the attention of investigators, dairymen and other cattle feeders from concentrates to roughage. This is not because concentrates are any less important than formerly, but because the roughage is coming to be recognized as relatively more important than it has been commonly regarded. Without adequate amounts of carotene, one of its very small but important fractions, the full nutritive value of the concentrates and other fractions of the roughage is not realized.

Roughage is peculiarly, indeed almost exclusively, the farmer's own problem. Neither the feed dealer nor the veterinarian has anything to do with it. It is good, bad or indifferent, depending on what kind the farmer grows, when he cuts it and how he cures and stores it. When a high grade is available in liberal quantities, it substantially reduces the amounts of concentrates that at one time were considered necessary in stock feeding. This makes the farmer less dependent than formerly on the feed market and reduces his cash outlay. At the same time, it implies that the knowledge and technique required for the production of high-quality roughage is no less important in contributing to his success than is his knowledge of what constitutes good types of animals and his skill in their breeding and care.

Finally, but not unimportant, the information that has been obtained places at the dairyman's disposal a means of producing an essential food richer than ever in vitamins that, when properly used, will make an increasingly important contribution to human nutrition and health. It cannot help but be a matter of satisfaction to him that when he is doing a better job of raising forage and feeding his stock, he is at the same time doing his bit for a better living standard and the general welfare.

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CALF SCOURS

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Calf scours is a term applied to dysentery or diarrhea of calves. There are two principal forms. The first form is an infectious bacterial disease affecting very young calves, often called white scours. The second form more often affects calves over a week of age and is usually associated with faulty management practices. This form is sometimes referred to as dietary scours.

White scours is most often caused by colon type bacteria. These germs are normal inhabitants of the intestinal canal of animals and do not usually produce disease. Protective antibodies are present in the blood stream of most adult cattle which protect them from invasion by this type of germ. These antibodies are transferred from the cow to the calf by way of the colostral milk. At birth the mucous membrane lining of the intestine of the calf is in an immature condition, so as to permit the absorption of antibodies from the colostral milk. In this immature condition, the intestine is more readily invaded by bacteria, taken in as the calf is fed. In some herds, the colon bacillus, by passing through and producing disease in a series of calves, attains great disease-producing power. The stage is then set for a severe outbreak of white scours. If cows are fed rations inadequate in vitamin A, the milk may be undesirably low in this element. Adequate vitamin A helps the calf to resist infection by way of the intestinal tract. In herds affected with Bang's disease, calves may be delivered prematurely and thus be very susceptible to this type of disease.

Dietary scours is more often seen in calves over a week old. While bacteria are important in causing this form, contributory factors are also very important. Some of these factors are overfeeding, feeding of cold milk, irregular feeding hours, milk low in vitamin A content, dirty feeding pails, wet or under-bedded pens, and allowing calves to suck one another's ears or mouths. Any one or several of these factors may be important, varying in different herds.

White scours, being an infectious disease, produces tissue changes characteristic of enteritis (inflammation of intestine) and septicemia (blood poisoning). Symptoms commonly seen by the attendant include marked prostration, persistent diarrhea, usually light in color, lack of appetite and rapid loss of weight. Very young calves are affected most often at 2-3 days of age. The course of the disease is rapid, and most affected calves die within 1-3 days after sickening.

Dietary scours presents, as a rule, a less severe picture. The outstanding symptom is an intermittent or continuous diarrhea, varying in color according to age of calf and feed. Such calves are often un-

thrifty, have a dull hair coat, are listless, and fail to grow as rapidly as is desirable.

For the treatment of white scours, specific serums and bacterins are prepared by biological manufacturers for use by veterinarians. These products have apparently shown considerable merit in some outbreaks. They must be properly handled and used as indicated by the producers. Logically, best results might be expected from a product prepared from germs found in cases on the particular farm. Necessarily this is an expensive procedure and only warranted where the livestock is very valuable. In addition to the biological products, stimulative treatments, blood transfusions and fluid injections are advisable. In some of the western states the feeding of acidophilus milk has been of considerable help. It should be emphasized here that because of the acute nature of the disease the assistance of a good veterinarian should be had as early as possible.

Cases of dietary scours are usually simpler to control than those of white scours. First, try to locate faulty feeding or management practices and correct them. Reduce the amount of milk fed by one-half. Give one or two raw eggs after each feeding, according to size of calf. A heaping tablespoon of the following mixture stirred into the milk may be helpful: equal parts by weight of baking soda, powdered ginger, and precipitated chalk.

Prevention should be the watchword in considering calf scours. The adage "an ounce of prevention is worth a pound of cure" is nowhere more applicable. Preventive measures are much the same for both type of scours.

1. Provide a clean, dry, well-bedded maternity stall in which the cow may calve. It is wise to clean and disinfect the maternity stall after each cow has calved there. It is presumed that the cow has been properly fed so that there will be adequate vitamin A in the milk on freshening.

2. Disinfect the navel of the calf with tincture of iodine as soon after birth as practicable.

3. Make certain that the calf receives colostrum milk as early as possible, by assisting it to nurse if necessary. Check to be certain that some milk is obtained from each quarter of the udder.

4. Do not allow the calf to consume an overload of colostrum. The present-day high-producing dairy cow produces more milk than even the most vigorous newborn calf can successfully consume. If the calf is to be pail-fed it may learn to drink more readily if removed from the cow soon after active bowel function is established.

5. Continue the feeding of dam's milk for a week after birth.

6. Begin pail feeding by giving milk amounting to 6-8 per cent of the body weight per day. Feed at regular hours and intervals, in clean pails, at a temperature of 98-100° F. Weak calves may do better if fed three times daily.

7. Keep the calf pens well bedded and **dry**. Elevated floors, of heavy, expanded metal are excellent. Single pens are to be preferred. If several calves must be kept together, it may be well to tie them after feeding milk so as to discourage sucking.

8. If scouring or other disease appears in calves, consult the best qualified veterinarian possible to employ.

FEEDING AND CONFINEMENT REARING EXPERIMENT WITH TURKEYS DURING 1940

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The production of market turkeys is an enterprise that has increased in importance on Michigan farms in recent years. Conservative estimates indicate that this state produces annually 600,000 turkeys with a valuation of \$2,000,000. Michigan is fortunately situated, with reference to climate and markets, for the production of quality turkeys and, with the more recent advances in understanding of the control of production factors, it seems probable that this business will become an even more important part of the general agricultural program. In all of the older sections of the country, the continued use of land for the rearing of birds has increased the hazards from contamination, and this is resulting in a gradual transition from the use of free range to some system of confinement or semi-confinement. Confinement systems have made possible a better control of losses due to diseases and predators, as well as other factors of production, but in turn have presented new problems, perhaps of a more fundamental nature. Confinement rearing methods, because they are more exacting in their demands for perfection of diet and general biological understanding, have stimulated a systematic study of the basic requirements of turkeys.

This report is the sixth of a series of turkey production studies in which the rearing method and manner of presenting data are comparable. Earlier trials resulted in the development of meshes which apparently are adequate for normal growth and the excellent development of turkeys reared under confinement conditions. The more recent work has been concerned with reducing feeding and rearing costs without limiting the finest development of the birds. In this connection, it appeared that very little was actually known about the factors that may influence either the proportion of grain to mash that the birds consume or a possible preference of turkeys for certain grains when given a free choice. The price of whole grains usually does not exceed half that of mash, and it is obvious that a relatively high proportion of grain in the diet is desirable. Since 1935, the grain percentages, under a free-choice system, have varied from as low as 19 to as high as 64.9 per cent and, up to this point, the cost per pound of gain has tended to decrease in a very consistent manner as the proportion of grain was increased. The two factors that have thus far resulted in the greatest intake of whole grain have been the use of high-protein meshes during the growing period and a free choice of the four grains: corn, wheat and oats and barley. The startling thing about the grain feeding trials has been the enthusiasm that turkeys display for oats. Oats are not usually given much consideration as a turkey feed, but

the birds consume them most eagerly from the start to the finish. Oats have comprised slightly more than 50 per cent, on an average, of all grain consumed. The desirability of utilizing as high a percentage as possible of farm-grown grains is self-evident and these studies are being continued in connection with observations on bird type and management methods.

1940 Objectives

The free-choice grain feeding trials of 1938 and 1939 indicated a possibility of influencing the proportion of grain to mash consumed and the resulting cost, by including several grains in the diet instead of but one (corn), as is a common practice. The four grains used in these trials were corn, wheat, oats and barley. When these four grains, instead of corn alone, are provided in separate compartments with the 27-per cent protein mash 7, the proportion of grain consumed consistently increases from an average of 30 per cent to an average of approximately 53 per cent of the entire diet. Oats have invariably been in first place and have averaged slightly more than 50 per cent of all the grain consumed. Because turkeys showed a definite preference for oats, and because of the impracticability of using numerous grains, it was decided to conduct trials in 1940 using a choice of corn and oats in comparison with corn alone as the grain part of the diet. Four pens of turkeys were used with these two grains, two pens of which were provided with the 27-per cent protein mash 7 and two pens with the 31-per cent concentrate mash 13. A check pen was included with the 27-per cent mash, and corn was the only grain. The remaining five pens used in the breed and type studies also included this latter combination. The turkeys receiving corn and oats were given a full opportunity to express a possible preference for either grain at the various stages of development. The feeding plan is given in Table 1-A of this article.

Cost and rearing studies were continued this year with Standard Bronze, small-type Bronze, and two crosses of small-type Bronze and

Table 1. Rations.

Mash Number	7	13
PROTEIN CONTENT OF MASH	Per cent	Per cent
Ground yellow corn	10	6
Ground oats	15	15
Wheat bran	10	10
Wheat flour middlings	10	—
Meat scrap	14	12
Fish meal	—	8.5
Dried skimmilk	10	10
Soybean oil meal	22	25
Alfalfa meal	5	10
Calcium carbonate	1	2
Salt	1	1
*Cod liver oil	2	.5
Total	100	100

*Cod liver oil of 85 vitamin D units was used in ration 7 while a "fortified" oil of approximately 400 units was used in ration 13. Cod liver oil was discontinued in all rations after the sixteenth week.

Table 1-A. Feeding plan.

Pen	Breeding	Number of Birds	Hatching Date	Mash	Grain
1.	Small Type.....	30	April 15.....	7	Corn
†2.	Cross-bred.....	30	April 15.....	7	Corn
†3.	Cross-bred.....	30	April 15.....	7	Corn
4.	Bronze.....	30	April 15.....	7	Corn
5.	Bronze.....	30	April 15.....	7	Corn, oats
*6.	Bronze.....	30	April 15.....	7 and 13	Corn, oats
7.	Small Type.....	30	May 27.....	7	Corn
8.	Bronze.....	30	May 27.....	7	Corn, oats
*9.	Bronze.....	30	May 27.....	7 and 13	Corn, oats
10.	Bourbon Red.....	30	May 31.....	7	Corn

Mash was available at all times from the first day to the end of the trials

Chopped fresh alfalfa was given daily after the sixth week. Grain and gravel were added to all diets at the end of the eighth week

*Pens 6 and 9 received mash 7 until the end of the eighth week, after which time both pens received mash 13 until the completion of the trials

†Pen 2 was composed of poults resulting from a cross-mating of a Standard Bronze male and small type females, while pen 3 were poults from a cross of a small type male and Standard Bronze females

Standard Bronze turkeys. A pen of the Bourbon Red breed was also included this year.

Observations as to the practicability of using a turkey house and also as to the use of a cobblestone yard for the rearing of market turkeys and the control of losses is a continuing project. The cobblestone yards, which are approximately 60 by 80 feet in size, had previously quartered 100 birds from the end of the starting period to maturity. In order to determine the possible bird capacity, the number of turkeys was increased to 135 in this year's trials.

Incubation and Starting Methods

The poults used in these trials were hatched at the poultry laboratory at East Lansing from eggs produced by the breeding flocks at the Lake City Experiment Station, with the exception of the Bourbon Reds which were purchased from a breeder as day-old poults. The hatching date for the different pens is given in Table 1-A. The young poults were kept for the first 24 hours in baby chick boxes. At the end of that time they were placed under small brooders in the laboratory in lots of about 40 poults each. Mash 7 in hoppers, together with water in vacuum fountains, was the only food given for the first week. Burlap was used as a floor covering for the first three or four days, after which time fine shavings were used until the birds were removed to Lake City.

Experimental Pens at East Lansing

At the end of the first week the poults were sorted into experimental lots of 30 each. Each lot was provided with an indoor pen, 4½ feet wide and 10 feet long, with an electric hover. Perches were added when the hovers were no longer required.

Because the poults for the second trial were hatched six weeks later than those of the first trial, it was necessary to remove the first lot to quarters in a laying house to give the preferred location in the

Table 2. Proportion of mash and grain consumed.*

(Total mash and grain consumed equal 100)

Pen	0-4 weeks		5-8 weeks		9-12 weeks		13-16 weeks		17-20 weeks		21-24 weeks		25-26 weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1.....	100	0.0	100	0.0	75.5	24.5	76.3	23.7	68.1	31.9	44.6	55.4	25.8	74.2
2.....	100	0.0	100	0.0	78.0	22.0	67.7	32.3	59.8	40.2	42.7	57.3	27.1	72.9
3.....	100	0.0	100	0.0	77.6	22.4	72.3	27.7	67.5	32.5	46.5	53.5	28.2	71.8
4.....	100	0.0	100	0.0	78.5	21.5	73.2	26.8	65.6	34.4	52.0	48.0	32.3	67.7
5.....	100	0.0	100	0.0	54.6	45.4	46.3	53.7	39.0	61.0	25.3	74.7	13.7	86.3
6.....	100	0.0	100	0.0	49.2	50.8	46.3	53.7	41.5	58.5	32.1	67.9	12.9	87.1
7.....	100	0.0	100	0.0	90.6	9.4	75.8	24.2	60.0	40.0	31.3	68.7	18.0	82.0
8.....	100	0.0	100	0.0	57.7	42.3	53.0	47.0	38.1	61.9	20.3	79.7	20.7	79.3
9.....	100	0.0	100	0.0	56.8	43.2	58.3	41.7	31.7	68.3	15.4	84.6	16.0	84.0
10.....	100	0.0	100	0.0	83.2	16.8	81.4	18.6	59.7	40.3	28.2	71.7	21.1	78.9

*Mash in hoppers at all times. Grain in hoppers after the eighth week until the end of the trials.

laboratory to the younger birds. The birds remained in these quarters until removed to Lake City at the end of the seventh week.

The poults of the second trial remained in the quarters first mentioned until the end of the fourth week when they, in turn, were removed to pens in the laying house until they were six weeks of age. With each lot it was necessary to keep the poults under the conditions described until their age and the weather conditions made it possible to transfer them to the large, open house at Lake City.

The Lake City Turkey House

At the Lake City Station, each group of turkeys was confined to a pen 10 feet wide and 24 feet deep in the open-front turkey house. This building, which is 100 feet long, is constructed of rough lumber and poles. The house is divided into 10 pens with wire and wood partitions. At the end and back walls are hinged panels that may be opened for summer ventilation. At the rear of each pen are perches and a screened dropping board. The floor is of concrete, and straw was used for litter.

Table 2-A. Pounds of mash and grain consumed by periods.

(Calculated on basis of one average bird)

Pen	1-4 weeks		5-8 weeks		9-12 weeks		13-16 weeks		17-20 weeks		21-24 weeks		25-26 weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1.....	1.48	0.0	6.36	0.0	6.90	2.23	8.80	2.73	8.00	4.72	6.74	8.36	2.37	6.43
2.....	1.58	0.0	6.95	0.0	7.21	2.66	8.28	2.95	8.01	4.35	6.61	8.95	2.41	6.51
3.....	1.77	0.0	7.03	0.0	7.88	2.26	8.28	3.51	8.81	4.71	8.30	8.55	2.70	6.89
4.....	1.76	0.0	6.94	0.0	7.72	2.51	8.52	3.45	9.70	6.11	9.20	8.70	3.16	6.66
5.....	1.71	0.0	7.04	0.0	6.21	5.33	6.33	7.35	6.82	10.63	4.91	14.48	1.45	9.10
6.....	1.61	0.0	6.92	0.0	6.68	5.86	7.12	7.65	10.79	6.92	14.75	1.35	9.27	9.10
7.....	1.16	0.0	6.23	0.0	8.05	10.57	8.27	10.81	7.18	6.22	11.46	1.63	9.33	9.33
8.....	1.79	0.0	6.36	0.0	6.41	4.78	9.20	8.45	18.71	4.28	16.73	1.91	9.53	9.53
9.....	1.71	0.0	6.80	0.0	6.35	4.75	7.93	8.21	13.46	3.00	16.45	1.61	9.50	9.50
10.....	1.08	0.0	8.19	0.0	6.07	1.23	10.32	8.58	9.08	6.07	4.05	10.18	1.31	4.94

Feeding Plan

With the free-choice grain feeding trials, pens 5, 6, 8 and 9 were used as is shown in Table 1-A which outlines the feeding plan. Pens 5 and 8 received mash 7 for the entire period. The birds in pens 6 and 9 received mash 7 until the end of the eighth week, at which time they were changed to mash 13 until the trials were completed. The formulas for these mashes are given in Table 1. Mash 13 is a concentrate mash, with a protein content of 31 per cent, and mashes of this type are expected to bring about the consumption of relatively large amounts of grain. Corn and oats were hopper-fed in an equal and free-choice manner to all four pens from the end of the eighth week until the birds were marketed. These grains were available at all times in a regular turkey feeding hopper which was provided with a central partition so as to make two equal compartments. Each compartment was 8 inches wide and 2 feet long, affording the birds opportunity to eat from either side. Pens 5 and 8 may be compared with pen 4 which received mash 7 for the entire period but consumed corn as the only grain.

Table 3. Pounds of feed consumed per pound of gain.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash.....	3.01	2.74	2.84	2.94	2.33	2.27	2.99	2.21	2.14	2.91
Corn.....	1.40	1.46	1.29	1.27	.79	.65	1.60	.82	.85	1.62
Oats.....					1.82	1.82		1.80	2.00	.....
Mash and Grain Total.....	4.41	4.20	4.13	4.21	4.94	4.74	4.59	4.83	4.99	4.53

The rearing and cost studies with the small-type Bronze strain were conducted with pens 1 and 7. The trials with cross-bred birds included pens 2 and 3. Pen 2 was composed of poults resulting from a cross of a Standard Bronze male and small-type females, while pen 3 was a cross of small-type male and Standard Bronze females. Pen 10 had birds of the Bourbon Red breed. The management of the five pens of birds of this group was the same as that of pen 4 in which Standard Bronze birds were used. Comparisons may therefore, be made between these pens in the tables which accompany this report.

Results

Proportion of Grain Consumed Increased when Two Grains Were Offered—With pen 4, which received mash 7 and corn as the only grain, the proportion of grain consumed was 30.9 per cent of the entire diet. This figure coincides with that obtained on numerous previous trials with this feed combination. When both corn and oats were fed with this same mash, as with pens 5 and 8 the percentage of grain consumed by choice was 52.8 and 54.3 per cent, respectively. This two-grain

Table 3-A. Pounds of feed consumed per pound of gain.

(Distributed by periods)

Pen	0-4 weeks		5-8 weeks		9-12 weeks		13-16 weeks		17-20 weeks		21-24 weeks		25-26 weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1.....	2.56	00 0	3.05	00.0	2.47	.80	3.27	1.01	3.97	2.35	2.87	3.56	1.41	4.05
2.....	2.33	00 0	3.09	00 0	2.27	.84	2.82	1.34	3.24	2.17	2.79	3.80	1.37	3.69
3.....	2.63	00 0	2.98	00 0	2.33	.67	2.83	1.07	3.67	1.76	2.82	3.24	3.11	7.93
4.....	2.80	00 0	2.64	00 0	2.46	.80	2.84	1.04	3.68	1.04	3.12	2.94	2.01	4.23
5.....	2.58	00 0	3.15	00 0	1.86	1.60	2.14	2.48	3.01	4.68	1.95	5.73	1.29	8.17
6.....	2.39	00 0	2.96	00 0	1.58	1.64	2.14	2.47	2.98	4.35	2.20	4.69	.87	5.88
7.....	2.38	00 0	3.19	00 0	3.04	.32	3.16	1.01	3.11	2.13	2.48	5.46	1.66	7.61
8.....	2.04	00 0	2.68	00 0	1.92	1.42	2.26	2.00	2.11	2.42	2.29	8.61	.91	4.56
9.....	2.87	00 0	2.91	00 0	2.17	1.65	2.14	2.21	1.77	3.80	1.52	9.36	.94	4.98
10.....	3.21	00 0	3.08	00 0	2.55	.51	3.28	.74	3.07	2.16	2.33	5.90	1.78	6.71

combination approximated, in percentage of grain consumed, the results of 1939 when four grains were offered. The turkeys receiving the two grains consumed an average of 0.67 pound more total feed per pound of gain than did the birds which received only corn as the grain, and this may be noted in Table 3. Computed in terms of an average 15-pound turkey, the birds receiving the two-grain combination required approximately 10 pounds less of the mash but 20 pounds more of the grain to finish than did those receiving the single grain. At the relatively high prices charged for grain in 1940, there was no advantage in cost per pound of gain with the two-grain combination over the single grain. However, the same relationship of grain to mash had given a substantial saving in the two previous years. It is evident that the farmer in a grain-producing area could have sold those grains through his turkeys at a very satisfactory price. The prices of all feeds used may be noted in Table 5. The final weights of both male and female turkeys were slightly greater with the pens receiving corn and oats than with the pens receiving corn alone. The birds in pens 6 and 9, which were fed the concentrate mash 13 in combination with corn and oats, consumed 52.1 and 57.3 per cent, respectively, of their total feed in the form of whole grain. These figures are also in close accord with those obtained during the two previous years when four grains were fed. There is need of more work on this subject, and these studies will be continued.

Turkeys Consumed More Oats Than Corn

In these, as in previous trials, the turkeys displayed their liking for oats in a no uncertain manner. There was also a remarkable consistency in the proportion of oats consumed by all four pens, regardless of the type of mash fed. When calculated on the basis of the proportion of oats to corn consumed per pound of gain, the ratio approximated 70 per cent oats to 30 per cent corn in so definite a manner that one might wonder as to the possible biological factors that influenced this choice. Pens 5, 6, 8 and 9, which had a choice of both oats and corn, consumed oats in the proportion of 70.0, 73.6, 70.0,

and 70.0 per cent, respectively, of the entire grain diet to 24 weeks of age. In other words, those turkeys chose to consume approximately $2\frac{1}{3}$ times as many oats as corn when both were presented on an equal basis. From the results thus far obtained it might be presumed that oats deserve a more important place in the turkey feeding program than formerly supposed.

Corn Gained in Preference During the Finishing Period

The turkeys did not show a noticeable interest for corn until the end of the eighteenth week of age. From then on to the finish, corn tended to increase in proportion to oats each week with all four pens which had a choice of grains. Corn, however, did not equal oats in amount consumed during any week with pens 5 and 6. Corn did exceed oats in amount consumed with pens 8 and 9 after the twenty-second and twenty-third week, respectively. This tendency may be noted in the accompanying table.

Time	Pen 5		Pen 6		Pen 8		Pen 9	
	Corn	Oats	Corn	Oats	Corn	Oats	Corn	Oats
9th to 18th week.....	21.6	78.4	21.9	78.1	11.8	88.2	13.2	86.8
19th to 24th week.....	36.9	63.1	30.1	69.9	46.0	54.0	42.8	57.2
Entire Period.....	30.2	69.8	26.4	73.6	31.2	68.8	29.9	70.1

Temperature may be one of the factors which influence the choice of grains with turkeys as it does with chickens. This may explain a difference in the distribution of the corn consumption between the first two pens and the last two pens. Pens 8 and 9 were hatched 6 weeks later than pens 5 and 6 and their grain period started July 27 and ended November 16.

Type Studies—The data with reference to differences existing with different types of turkeys are presented in the various tables which are a part of this report. Comparisons may be made between the different

Table 4. Feed cost per pound of gain.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash.....	\$.075	\$.069	\$.071	\$.074	\$.058	\$.062	\$.075	\$.055	\$.058	\$.073
Corn.....	.021	.022	.019	.019	.012	.009	.024	.012	.013	.024
Oats.....					.026	.026		.025	.028	
Mash and Grain Total.....	\$.096	\$.091	\$.090	\$.093	\$.096	\$.097	\$.099	\$.092	\$.099	\$.097

sorts of birds as well as with differences in diet. This is a continuing study, and an analysis of the data will be made at a later date.

Feed Consumed Per Pound of Gain

One of the measures of the efficiency of a diet is the proportion of mash and grain as well as the total quantity of these ingredients that is required to produce a unit of gain in weight in the birds. Relatively high-grain consumption usually results in a corresponding decrease in the amount of mash consumed. The average amount of feed per pound of gain to 24 weeks of age is given in Table 3. The amount of feed per pound of gain is distributed by periods in Table 3-A.

Table 5. Feed prices per 100 pounds.

Feed	Pen									
	1	2	3	4	5	6	7	8	9	10
Mash 7.....	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50	\$2.50
Mash 13						2.80			2.80	
Corn	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Oats.....					1.40	1.40		1.40	1.40	

Average Cost of Producing a Pound of Gain

The cost of producing a unit of gain should be considered in determining the merit of any ration. This information is given for each pen in Table 4. The pens consuming a high percentage of grain are at some disadvantage because grains cannot be purchased advantageously in the low-grain producing area where the turkeys are reared. The prices of 85 cents per bushel for shelled corn and 45 cents per bushel for oats, as charged in computing those costs, were considerably higher than the prices which prevailed in most grain farming regions in 1940.

Table 6. Growth of turkeys.

(Average weight in pounds)

Pen	4 weeks		8 weeks		12 weeks		16 weeks		20 weeks		24 weeks		26 weeks	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1.....	.85	.79	3.20	2.45	6.52	4.65	9.92	6.52	12.75	8.04	16.11	9.14	18.27	10.03
2.....	.97	.85	3.50	2.84	7.33	5.44	10.96	7.77	14.42	9.39	17.92	10.74	20.50	11.79
3.....	.91	.80	3.44	2.80	7.21	5.70	10.98	8.24	14.38	9.80	18.17	11.50	19.92	12.68
4.....	.88	.82	3.38	2.95	7.10	5.65	10.84	8.29	14.45	10.36	18.06	12.19	19.79	13.49
5.....	.93	.84	3.38	2.93	7.38	5.68	11.09	8.41	14.90	10.66	18.42	12.53	21.09	13.80
6.....	.76	.80	3.41	2.79	7.38	5.61	11.45	8.21	15.12	10.18	19.05	11.91	20.92	13.96
7.....	.76	.63	3.04	2.39	6.07	4.70	9.89	7.32	14.00	9.86	16.64	10.91	17.75	11.54
8.....	.87	.77	3.42	2.85	7.02	5.71	11.56	8.93	16.06	12.06	18.32	13.49	20.95	14.65
9.....	.84	.79	3.27	2.94	6.51	5.52	10.97	8.56	15.66	11.15	17.78	12.51	20.19	13.60
10.....	.59	.52	2.48	2.07	5.36	4.16	9.38	6.72	13.15	8.99	15.70	10.24	16.91	10.66

Table 6-A. Distribution of pounds gain by periods.

(Calculation on basis of one average bird)

Pen	1-4 weeks	5-8 weeks	9-12 weeks	13-16 weeks	17-20 weeks	21-24 weeks	25-26 weeks
	Total Lb. Gain	Total Lb. Gain	Total Lb. Gain	Total Lb. Gain	Total Lb. Gain	Total Lb. Gain	Total Lb. Gain
1.....	0.58	2.08	2.79	2.69	2.02	2.34	1.58
2.....	.68	2.25	3.17	2.94	2.47	2.35	1.76
3.....	.67	2.86	3.88	3.28	2.67	2.94	.87
4.....	.63	2.60	3.13	3.34	2.63	2.95	1.57
5.....	.66	2.24	3.83	2.96	2.26	2.59	1.11
6.....	.67	2.33	3.58	3.31	2.56	3.14	1.58
7.....	.50	1.96	2.64	3.33	3.36	2.10	.91
8.....	.61	2.37	3.33	4.05	4.00	1.95	2.09
9.....	.59	2.33	2.87	3.71	3.53	1.75	1.70
10.....	.34	1.65	2.38	3.12	2.81	1.73	.78

1940 Feed Prices—The average prices paid for the different mashes and grains are shown in Table 5. Mash prices advanced 10 per cent in 1940 over those of 1939. With the grains, corn advanced 11 per cent and oats 14 per cent over the previous year.

Growth Rates—The rate of growth of the different groups may be noted from the data presented in Table 6 which gives the average weights of both male and female turkeys at the end of each four-week period. Table 6-A shows the distribution of pounds of gain by periods as calculated on the basis of one average bird.

Mortality—In these trials, a bird once removed from the pen because of injury or crippling is not returned even though it may eventually recover. It is the same as dead so far as this report is concerned. On this basis of calculating mortality, the total loss to 24 weeks of age was only 15 birds out of the 300 which were started on

Table 7. Final weights of turkeys in pounds at 24 weeks of age.

	Pen									
	1	2	3	4	5	6	7	8	9	10
Birds Started...	30	30	30	30	30	30	30	30	30	30
Surviving Birds...	29	30	29	27	28	28	27	30	30	27
Total Weights...	376.7	422.8	465.2	428.9	415.8	462.0	386.3	496.2	449.2	331.0
Number Males...	16	14	17	17	11	18	16	19	14	10
Heaviest Male...	18.0	21.3	21.4	20.1	21.3	21.4	19.5	21.4	20.5	17.0
Lightest Male...	11.8	15.8	16.1	16.5	13.9	16.0	12.9	16.4	14.5	13.8
Average Weight...	16.11	17.92	18.17	18.06	18.42	19.05	18.64	18.32	17.78	15.70
Number Females...	13	16	12	10	17	10	11	11	16	17
Heaviest Female...	10.0	13.9	13.9	13.6	15.0	13.5	13.4	14.4	14.9	11.8
Lightest Female...	8.3	9.2	9.9	9.6	11.4	10.6	9.4	12.8	10.4	8.7
Average Weight...	9.14	10.74	11.50	12.19	12.53	11.91	10.91	13.49	12.51	10.24

the trials when one week old. The number of birds surviving in good condition was 285 and their distribution by pens may be noted in Table 7.

Final Weights—The final weights of both male and female turkeys are given in Table 7. This table also shows the range in weights of the birds of each sex and the number surviving the trials. Crooked keels and other faults were rare and the quality was generally excellent.

Summary

The feeding of corn and oats to turkeys on a free-choice basis consistently increased the total amount of grain consumed and the proportion of grain to mash, as compared with the feeding of corn alone.

The total amount of feed consumed per pound of gain was slightly greater when both corn and oats were fed than when corn was the only grain.

There was a slight advantage in the final weights of the birds receiving the two grain combinations as compared with the single grain.

The turkeys consumed on the average $2\frac{1}{2}$ times as much oats as corn per pound of gain and all four pens were consistent in this proportion.

When corn, wheat, oats, and barley were fed in a free-choice manner in the 1938 and 1939 trials, oats were always in first position and usually exceeded the combined total of the other three grains.

It is probable that oats deserve a more important place in the diet of turkeys than formerly supposed.

In these trials, the turkeys did not show much interest in corn until about the nineteenth week of age.

There are indications that environmental temperature is one of the factors that influence the consumption of corn.

Mash 7 continues to produce thrifty turkeys with smooth, lustrous plumage and excellent market quality. This is recommended as an excellent all-purpose mash for starting baby poults and for the development of turkeys of good quality at moderate cost.

The cobblestone yard, which has an area of 480 square feet, proved very satisfactory in the rearing of 135 turkeys to maturity with exceptionally low losses. The several years of work with turkeys reared in confinement have clearly demonstrated the practicability of this method for the production of market turkeys. The overhead investment has been reasonable, labor has been simplified, and mortality from diseases and predators has ceased to be a serious problem.

WRAPPING MEAT FOR FROZEN STORAGE

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All meat stored in commercial or home freezing units should be properly wrapped before freezing to prevent soiling in handling, and to prevent the meat from absorbing odors of other products in storage and, to avoid loss of weight through dehydration, the cause of "freezer burn". It is very essential that every precaution be taken to insure a clean and desirable product when the meat is cooked.

The collection of frost on refrigerator coils is an evidence of moisture in the storage room. This cannot be entirely prevented under normal conditions. If meat, however, is not properly wrapped, part of this moisture may come from the meat juices. The result is loss of weight, a dried-out appearance of the meat, and a less desirable product.

Proper wrapping first suggests a wise choice of good quality wrapping material that is substantial as well as moisture-vapor-proof. In experiments conducted at the Michigan Agricultural Experiment Station, pork chops wrapped in ordinary 50-pound "butcher" paper shrank 11.2 per cent in weight during an 8-month storage period, while under the same conditions pork chops wrapped in moisture-vapor-proof cellophane shrank only 0.18 per cent in weight. Likewise, a 40-pound paper waxed on the inside allowed only 1.8 per cent loss in weight over the 8 months' storage period. The pork chops were dehydrated $\frac{1}{8}$ to $\frac{1}{4}$ inch deep when wrapped with 50-pound "butcher" paper and little if any dehydration of the chops could be noted when either the moisture-vapor-proof cellophane or waxed 40-pound paper was used. Therefore, it is apparent that ordinary wrapping materials which are not moisture-vapor-proof should not be used. Moisture-vapor-proof cellophane is an excellent wrapper to prevent moisture loss and should therefore be used when meat is stored longer than 6 months or is to be used for display purposes. The 40-pound paper, used with the waxed side next to the meat, is a very satisfactory and economical wrapper for frozen meat that is kept 6 months or less. It is recommended that the locker patron consult some recognized authority, such as his local locker operator or county extension worker, before using a new wrapping material.

Methods of Wrapping

There are several methods of wrapping pieces of meat. A common one with roasts is to start at the corner of a medium-sized sheet and roll until the entire piece is covered with one thickness of paper, then crease and fold in the ends. Continue rolling until the roast is double wrapped and the package is firm and free from air spaces. After tying, such a package should be neat, secure and virtually moisture-vapor-

Each package should be properly labeled showing kind of meat, cut of meat, locker number, and date of storage. Different-colored paper or string may be used for quick identification of pork, beef, lamb, or veal. Healthy, well-finished meat animals properly butchered, chilled and cut, then wrapped as directed and quick-frozen, produce meat equal in quality to similar fresh unfrozen meat.

Suggestions on Home Preparation of Meat

Farmers living within driving distance of freezer locker plants can guarantee themselves a uniform quality of meat at a saving by using locker facilities for storage of home butchered meat.

For complete information on home preparation of meat and the preservation of meats in freezer lockers, consult your county agricultural agent or send to the Michigan State College Bulletin Room for copies of the following:

Ext. Bul. 223—Preservation of Meats and Poultry in Frozen Food Lockers.

Ext. Bul. 151—The Home Meat Supply.

Ext. Folder F-7—Home Prepared Pork Reduces the Food Budget.

FOAMING OF HOMOGENIZED MILK

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Several inquiries have been received relative to the foaming of homogenized milk. Particularly was foaming troublesome at the bottler where it resulted in partially filled bottles. A survey of several plants revealed that not all of them were experiencing troubles along this line. In view of the fact that in some plants the bottler was operated at a slow speed to synchronize with the capacity of the homogenizer, it was not surprising that difficulty with short-filled bottles due to foaming was not encountered. Generally, this difficulty was overcome by exercising caution in operations such as, operating the bottler at slow speed; having and maintaining a maximum head of milk in the supply tank; pumping milk at a pressure that splashing of milk at spreader pipe was minimized; having a short drop from the cooler coils to the cooler reservoir; and having air-tight connections in the lines.

That homogenized milk may give rise to some problems of handling because of foaming is not surprising in view of the data presented by Sanmann and Ruehe (1930), indicating that homogenization increased considerably the foaming of whole milk as measured at 40° and at 80° F. Trout, Halloran, and Gould (1935) showed that the amount and character of foams on homogenized raw and on homogenized pasteurized milk varied greatly, but hitherto no trials have been run to determine the relative foaming ability of milk homogenized and then pasteurized as compared with that homogenized after pasteurization. Experiments were conducted to ascertain if the time of homogeniza-

tion with respect to pasteurization would influence markedly the foaming of the milk.

The foaming of the milk was determined one hour after homogenization and cooling by whipping 200 ml. of the sample for 30 seconds in a malted milk mixer, then pouring the whipped sample into a measuring cylinder and taking the reading after 15 seconds. The relative foaming was expressed in percentage increase over the original volume. The data are presented in Table 1.

Table 1. The foaming of milk homogenized before and after pasteurization.

Trial	Fat test	The foaming ability* of milk when the milk was homogenized at 2500 pounds		
		At 100° F prior to pasteurization	At 143° F after pasteurization	At 100° F after pasteurization
	percent	percent	percent	percent
1.....	4.25	70.0	107.5	110.0
2.....	3.50	57.5	115.0	100.0
3.....	5.00	85.0	125.0	110.0
4.....	3.40	72.5	105.0	95.0
Average.....	4.04	71.2	113.1	104.0

*The foaming ability is expressed in percentage increase over the original volume.

From these limited trials it would appear that milk homogenized raw at 100° F. and then pasteurized is not so susceptible to foaming as milk homogenized after pasteurization. Apparently a slight decrease in foaming may be expected when the pasteurized milk is homogenized at 100° F. rather than at 143° F. However, this difference is slight and would appear to be of no commercial importance. On the other hand, the lesser foaming of the milk homogenized at 100° F. prior to pasteurization might be of commercial significance if the milk were pasteurized immediately after homogenization to prevent development of rancidity. It must be emphasized that the milk in these trials was homogenized raw at 100° F., a very hazardous temperature zone for homogenization without immediate heat inactivation of the enzyme lipase.

Two trials were run also in which the milk was homogenized at 2500 pounds at 130° F. before pasteurization as well as after pasteurization. No significant difference was noted between the foaming of the milk homogenized at 130° F. before pasteurization and that homogenized after pasteurization such as was observed when the milk was homogenized raw at 100° F.

Considering the hazard of lipolysis when homogenizing raw milk it would seem that the practical solution to foaming difficulties of homogenized milk is not through manipulation either of the homogenization temperature or of the sequence of processing, but in careful plant operations incident to conveying the milk from the pasteurizer to the bottles, such as those previously mentioned.

Summary

The extent of foaming of homogenized milk was influenced by the time of homogenization with respect to pasteurization. Raw milk homogenized at 100° F. and then pasteurized exhibited considerably less foaming than that homogenized after pasteurization. Lowering the homogenization temperature of pasteurized milk from that of pasteurization, 143° F. to 100° F. reduced slightly the foaming, but was considered to be of no commercial importance. It appears that difficulties with foaming of homogenized milk may be overcome by correcting some handling defect rather than by varying the temperature or sequence of homogenization.

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STRENGTH PROPERTIES OF CHINESE ELM GROWN IN MICHIGAN

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SECTION OF FORESTRY

In the August issue of the 1940 Quarterly Bulletin Bowman* reported on the growth of Chinese elms (*Ulmus pumila* L.), from Fengtai Province, China, planted in Michigan in 1916 and 1917. Two of the largest elms were cut in April 1940. At the time of felling, these trees measured 18 and 19 inches in diameter, breast high; this represents an average annual growth of from 0.75 to 0.79 inch in diameter. Wood specimens measuring 2 by 2 inches in the cross section and of suitable lengths, were taken out of the larger of the two trees for determination of strength properties. This wood was dried in the kiln operated by the Forestry Department to about 10 per cent moisture, prior to testing.

Description of Wood

Wood of Chinese elm is moderately heavy with a specific gravity of about 0.5, based on oven-dry weight and volume. The sapwood is light yellow, while the heartwood ranges from brown to dark brown, with a reddish tinge. The wood when planed exhibits a pleasing figure caused by the alternate bands of the open-textured, lighter colored spring wood and the close-textured, darker summer wood. The growth

*Bowman, A. B. Chinese Elm in Michigan. Michigan Agr. Exp. Sta. Quart. Bull. **23** (1): 27-28.

rings are distinct; the wood is ring porous (Fig. 1, see insert in center spread), with the spring wood consisting of several rows of large open pores, distinctly visible with the naked eye, while the summer wood is figured with numerous wavy bands, consisting of small summer wood pores; the rays are plainly visible without the aid of a magnifying lens.

When compared with the native elm, Chinese elm resembles slippery elm (*Ulmus fulva* Michx.) on the basis of color of its heartwood, and the number of rows of pores in the spring-wood portions of the growth rings. Chinese elm, however, can be easily separated from slippery elm by rays which are indistinct without a hand lens in the latter species and plainly visible with the naked eye in the former.

Strength Tests*

The tests were made on clear specimens cut to standard sizes as recommended by the United States Forest Products Laboratory, Madison, Wis. The following tests were performed on the Riehle Universal testing machines: static bending, compression parallel to grain, shear parallel to grain, and hardness. Five specimens each were used in the static bending and in the compression tests and seven each in the other two. The results of these tests are summarized in Table 1. In Table 2 the average strength data for the three native elms are also included so that a comparison of the strength properties of the native and the Chinese elms can be made.

Table 1. Strength properties of Chinese elm.

(At 12% Moisture Content)

Static Bending				Compression Parallel to Grain in lb. per.sq. in		Shear Parallel to Grain in lb. per sq. in.		Hardness Load required to embed a 0.444 in ball to ½ its diameter					
Modulus of Elasticity in 1,000 lb. per sq in		Modulus of Rupture in lb per sq. in						End		Radial		Tangential	
Range	Av.	Range	Av	Range	Av.	Range	Av.	Range	Av	Range	Av.	Range	Av.
1,060 to 1,236	1,154	9,345 to 13,125	11,077	6,247 to 6,410	6,327	1,350 to 1,817	1,587	1,160 to 1,385	1,265	920 to 1,115	947	983 to 1,086	1,018

In analyzing the strength data for Chinese elm, and especially in comparing that species with the native elms, it must be recognized that the strength values for Chinese elm are based on a limited amount of material, whereas those for the American species are derived from tests on specimens obtained from a number of trees grown on different sites and in different localities. The average strength values for the American species may be considered, therefore, as approaching

*Acknowledgment is due to F. E. Dickinson and Everett Ellis, graduate students in forestry, for assistance in conducting strength tests.

Table 2. Average strength properties of three native* and the Chinese elms.

Species	Static Bending		Compression Parallel to Grain in lb. per sq. in.	Shear Parallel to Grain in lb. per sq. in.	Hardness Load required to embed 0.444 ball to ½ its diameter	
	Modulus of Elasticity in 1,000 lb. per sq. in.	Modulus of Rupture in lb. per sq. in.			End	Side
	average	average	average	average	average	average
American elm (<i>Ulmus americana</i>)	1,340	11,800	5,520	1,510	1,110	830
Rock elm (<i>Ulmus Thomasi</i>)	1,540	14,800	7,050	1,920	1,510	1,320
Slippery elm (<i>Ulmus fulva</i>)	1,490	13,000	6,300	1,630	1,120	860
Chinese elm (<i>Ulmus pumila</i>)	1,154	11,786	6,327	1,587	1,265	983

*The data for native elms are from "Strength and related properties of woods grown in the United States" by L. J. Markwardt and T. R. C. Wilson. U.S.D.A. Tech. Bull. 479, 1935.

the true average for each species closer than the figures for the Chinese elm.

Examination of the data presented in Tables 1 and 2 indicates that the fast-grown wood of Chinese elm is inferior in stiffness (as indicated by the lower modulus of elasticity) to the wood of average strength of the three American species of elm. It is comparable to American elm (*Ulmus americana*) in ability to support a slowly applied load in static bending (as determined by the modulus of rupture) and in shear parallel to the grain, but is inferior in this respect to slippery elm (*Ulmus fulva*) and to rock elm (*Ulmus Thomasi*). In compression parallel to the grain, the samples of Chinese elm tested were superior to American elm, comparable to slippery elm and inferior to only rock elm. In hardness, both on end and side grain, Chinese elm was excelled only by the rock elm. It may be concluded therefore, that on the basis of its strength properties, fast-grown Chinese elm may be considered equal to American and slippery elms except in static bending, where it has a considerably lower modulus of elasticity than the native species.

HATCHING ABILITY OF POULTRY

I.

TEXTURE OF EGG SHELLS IN RELATION TO LOSS OF WEIGHT DURING INCUBATION

E. W. HENDERSON*

SECTION OF POULTRY HUSBANDRY

A characteristic of egg shells commonly observed by means of a candle has been variously designated by poultrymen as: (1) "mottling" (2) "porosity" or (3) "texture". Opinions concerning the significance of this characteristic differ materially. Some of the common suppositions are that eggs with porous or mottled shells are "thin" or "weak" and that they lose moisture rapidly and they seldom hatch.

Experimental attempts to determine the significance of texture of shells have demonstrated some significance but lack of agreement with respect to actual physical relationships to visual conditions suggests that additional research is needed. Apparently there are several conditions of shell texture that appear to be similar when observed before an egg candle.

Holst, Almquist and Lorenz (1932) described a mottled condition of shell texture as it appears before an egg candle and under a microscope. The condition they illustrated seem to be very nearly the same as that shown in Fig. 1 (see insert in center spread). They concluded that the "mottled" appearance is the result of variable translucency but that the translucent spots are not associated with actual pores in the shell. Almquist and Burmester (1933) described another translucent condition which is associated with an abnormal type of shell designated as "glassy"; the mottled condition appears very much the same but the eggs are rather easily distinguished once the difference is recognized. Perry (1936) described a condition, which appears to be the same as that of Holst, *et al.* (1932), but Perry designated it as "apparent porosity". He found that the rate of loss of weight in six months cold storage was associated with the degree of translucency of the shell. This result was in general agreement with that of Holst, *et al.* (1932), notwithstanding the fact that they showed the translucent spots were not associated with actual pores. Almquist and Burmester (1933) found that their glassy shelled eggs had a *lower* rate of moisture loss than normal eggs but they write that "In glassy shells the more translucent areas appear to be located at the pores." It is generally known that the actual pores in the shell of an egg are micro-

*Assoc. Prof. J. A. Davidson assisted in the weighing of eggs in set 4 and the operation of the incubator. Graduate students Harry Hathaway and B. Robinson assisted in candling and recording data.

scopic in size, therefore not necessarily associated with the *macroscopic* translucent spots.

From a review of research on shell texture there appears to be some ambiguity in the situation which may be summarized as follows: Holst, *et al.* write that "Uneven egg shell translucency ordinarily called poor shell texture has been found to be caused by the presence of moisture distributed in a non-uniform manner throughout the shell proper. The results of the experimental work rule out . . . the possibility of thin areas in the shell as an explanation of the translucent spots . . . storage experiments seem to indicate little significant difference between the several shell texture grades as far as . . . rate of shrinkage is concerned." Perry (1936) found "apparent porosity" and shrinkage to be significantly associated. Almquist and Burmester (1933) found that the spots in glassy eggs were associated with pits and pores, but negatively associated with rate of moisture loss. Glassy eggs, being "abnormal," do not appear to be comparable at all to the great majority of eggs.

It is somewhat difficult to understand why candling spots and pits and pores are associated in glassy eggs, if not in ordinary eggs. It may be that the pits in egg shells contribute to the uneven distribution of moisture and thus to the translucent spots with water being essential to visibility before a candle. It can be demonstrated that at least some of the translucent spots in ordinary eggs are associated with pits in the shell even though there may be no pore at the bottom. This may be done by drawing a circle around some of the spots with a lead pencil and then moving the egg gradually from the candle until the shadows show the pit if present.

Regardless of what the explanation may prove to be experimental work to date indicates a positive association between the translucent spot condition of egg shells when candled and the rate of moisture loss, except in abnormal glassy shells. This association is supported by the results of the experiment described herewith.

Experimental Methods

Object—The object of this investigation was to determine whether varying degrees of a well known condition of egg shells designated "texture" as observed before an egg candle are associated with rate of moisture loss.

General Procedure

The range in degree of "apparent porosity" or texture of the shells of more than 2,300 eggs was scored by means of an ordinary egg candle.* The eggs used were about equal in number from both white- and brown-shelled producing breeds such as White Leghorns, Barred Rocks, Rhode Island Reds. After scoring each individual egg by a scale ranging from 1 to 5 the eggs were weighed in grams and set in a commercial cabinet type of incubator with automatic temperature and humidity controls. The temperature of the incubator was maintained at 99.75° F. and the relative humidity at approximately 65 per

*Other shell and candling observations were recorded at the same time but results with these conditions will be reported at a later date.

cent. At the end of 18 days the eggs were weighed individually a second time and the loss of weight determined and calculated as a percentage of the original weight of each egg. This equalized variations in loss of weight due to differences in original weight of the eggs. No distinction was made between the fertile and infertile eggs. (*See insert in center spread.*)

Trend in Rate of Weight Lost

It is obvious from Table 1 and Fig. 2 that there is a close association between shell texture, candling score and percentage of weight lost in an incubator in 18 days. In every case except one the mean percentage loss of weight increased as the shell texture score of the egg increased. The exception in the average is between score "3" and score "4". This may have been the result of an error in judgment in scoring for the percentage of eggs in class three is high as compared with the other sets. There is a difference in rate of loss between sets which may be due to the result of differences in incubation conditions or conditions inherent within sets.

Table 1. Percentage moisture lost by incubating eggs of different shell texture scores.
SCORES

Set No	Date	1		2		3		4		5	
		N	Percent Loss	N	Percent Loss	N	Percent Loss	N	Percent Loss	N	Percent Loss
1.....	5/23/40	69	11.85	296	12.96	119	13.49	49	13.25	48	14.39
2.....	10/30/40....	16	10.12	285	10.81	140	11.17	47	11.27	16	12.10
3.....	11/18/40....	13	10.33	114	10.94	143	11.70	125	11.38	107	12.03
4.....	5/ 6/41....	178	9.98	261	9.91	161	10.25	90	10.26	37	14.18
Average.....		276	10.47	956	11.24	563	11.53	311	11.33	208	12.96

N = Number of Eggs

These results seem so conclusive that they are presented without a statistical analysis which will be included in a later publication.

It will be noted that, in most instances, the percentage loss of moisture is not unduly excessive except for those eggs with shell texture scores of 5. In a report of Lamson and Kirkpatrick (1918) hatchability was not affected until the percentage loss of moisture exceeded 11.5 per cent. Hatching ability is affected by a multitude of factors and the question of whether the eggs with high texture scores lose moisture in an amount which affects hatchability may be inferred but proof must await further analysis of the data. It seems clear that rate of moisture loss may be reduced by selecting eggs with candling "texture" which does not exceed a score of 3. If it is necessary to set eggs with a "texture" score above 3, operating the incubator at a higher relative humidity may be desirable.

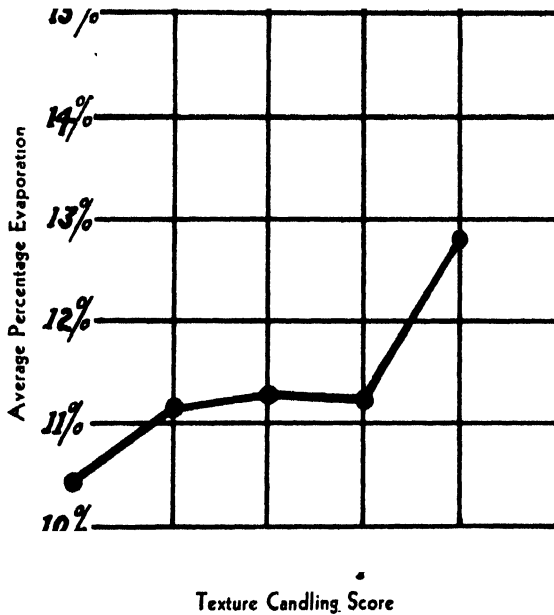


Fig. 2.

(For Fig. 1, see insert in center spread.)

It should not be inferred that this report indicates that the number of actual microscopic pore openings in the shell are associated with the candling appearance. Why the eggs with higher texture scores lose moisture at a faster rate is still a matter of speculation. It may be that some of the translucent spots are associated with pits and pores of greater than microscopic diameter. It seems possible also that moisture may be evaporated by passage directly through the shell proper and not necessarily through the pores alone.

Summary and Abstract

A well known condition of texture of egg shells commonly observed by candling and variously designated by such terms as "porosity," "apparent porosity," shell "texture," "mottled shells," "spots" is described and illustrated. The comparability of the condition to those previously described is discussed. The variations in texture are estimated by scoring with a range of one to five. The percentage moisture lost by the eggs in the five candling score classifications was determined by incubating them for 18 days. The percentage moisture lost was positively associated with the candling score. The mean percentage loss of the eggs which were scored one was 10.47 and that of the eggs which were scored five was 12.91. No relationship between microscopic pores and candling "texture" is shown.

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THE INFLUENCE OF THE TIME AND TEMPERATURE OF HOMOGENIZATION ON CERTAIN PROPERTIES OF THE MILK

G. M. TROUT AND M. V. SCHEID
SECTION OF DAIRY HUSBANDRY

Inquiries are received from time to time concerning the sequence of processing milk when homogenization is one of the processes involved. The market milk processor fully appreciates that pasteurization must accompany the homogenization of milk in order to inhibit the development of rancidity and that clarification to eliminate sedimentation may be necessary, particularly at certain seasons of the year and with some milks. Furthermore, he recognizes that the milk fat must be in a liquid state, if homogenization is to be effective. Consequently, several systems of processing involving homogenization of milk or sequences of processing are possible, each of which with proper control, yield a satisfactory bottle of homogenized milk. Some of the many possibilities are:

1. Preheat, homogenize, clarify, pasteurize, cool.
2. Preheat, clarify, homogenize, pasteurize, cool.
3. Preheat, clarify, pasteurize, homogenize, cool.

Hood and White (1934) found in a survey of 38 Canadian plants that 12 plants homogenized before and 26 after pasteurization. Layson (1936) surveying 16 plants reported that 5 homogenized before and 11 after pasteurization. Many investigators have recognized that from the sanitary standpoint homogenization before pasteurization was the preferred sequence of processing inasmuch as homogenization after pasteurization introduced another piece of equipment with which the pasteurized milk came in contact. However, they realized that other factors such as the volume and percentage of milk homogenized and facilities for preheating the milk to a homogenizable temperature and for subsequent heating of the milk to inactivate the enzyme responsible for the major flavor defect influenced the choice of time at which to homogenize.

Sequence of Processing in Some Michigan Milk Plants

A survey of 23 milk plants in Michigan in which milk was being homogenized showed that 19, or 82.6 per cent, of them were homogenizing after pasteurization. The specific pasteurization and homogenization temperatures and homogenization pressures used in processing milk in the various plants surveyed are given in Table 1.

The pasteurizing temperatures in these plants ranged from 142° F. for 30 minutes to 160° F. for 20 minutes. Thirteen of the plants pasteurized the milk at 145° F. or above, seven of them using exposures of 150° F. or above for 30 minutes. The remainder, or 10 plants, pasteurized milk at approximately 143° F. for 30 minutes. Undoubtedly,

Table 1. The time and temperature of homogenization with reference to other processes in 23 Michigan milk plants.

Plant No.	SEQUENCE AND TEMPERATURE OF PROCESSING	
	When homogenizing <i>before</i> pasteurization	
3	Clarify 40°F. , preheat; homogenize 130°F. , 3000 pounds, pasteurize 143°F. 30 min. , cool	
6	Clarify 40°F. , preheat, homogenize 130°F. , 3000 pounds, pasteurize 150°F. 30 min. , cool	
9	Preheat, homogenize 145°F. , 3000 pounds, pasteurize 150°F. 30 min. , cool	
23	Preheat; clarify 110°F. , preheat, homogenize 140°F. , 3000 pounds, pasteurize 147°F. 30 min. , cool	
	When homogenizing <i>after</i> pasteurization <i>with</i> clarification	
1	Preheat, clarify 155°F. , pasteurize 160°F. 20 min. ; homogenize 155°F. , 2500 pounds, cool	
4	Clarify 36°F. ; pasteurize 145°F. 30 min. ; homogenize 145°F. , 2500 pounds; cool	
5	Clarify 40°F. ; pasteurize 145°F. 30 min. ; homogenize 145°F. , 2500 pounds, cool	
10	Preheat; clarify 125°F. ; pasteurize 148°F. 30 min. , homogenize 148°F. , 2200 pounds, cool	
17	Clarify 60°F. ; pasteurize 140°F. 30 min. ; homogenize 146°F. , 2500 pounds, cool	
	When homogenizing <i>after</i> pasteurization <i>without</i> clarification	
2	Pasteurize 142°F. 30 min. , homogenize 130°F. , 2500 pounds; cool	
7	Pasteurize 143.5°F. 30 min. , homogenize 143.5°F. , 2500 pounds; cool	
8	Pasteurize 150°F. 30 min. , homogenize 150°F. , 2000 pounds; cool	
11	Pasteurize 143°F. 30 min. ; homogenize 143°F. , 2500 pounds; cool	
12	Pasteurize 150°F. 30 min. ; homogenize 150°F. , 2500 pounds; cool	
13	Pasteurize 155°F. 30 min. ; homogenize 155°F. , 3000 pounds, cool	
14	Pasteurize 155°F. 30 min. ; homogenize 155°F. , 2500 pounds; cool	
15	Pasteurize 150°F. 30 min. ; homogenize 150°F. , 2500 pounds, cool	
16	Pasteurize 143°F. 30 min. ; homogenize 143°F. , 2500 pounds, cool	
18	Pasteurize 144°F. 30 min. ; homogenize 144°F. , 2500 pounds; cool	
19	Pasteurize 148°F. 30 min. ; homogenize 148°F. , 2500 pounds; cool	
20	Pasteurize 144°F. 30 min. ; homogenize 144°F. , 2200 pounds; cool	
21	Pasteurize 143°F. 30 min. ; homogenize 143°F. , 2000 pounds; cool	
22	Pasteurize 143°F. 30 min. ; homogenize 143°F. , 2500 pounds; cool	

the deciding factor in selecting a pasteurizing temperature, above that required by public health regulations, is whether the entire lot of milk is to be homogenized or whether a portion of it is to be bottled as unhomogenized milk. Cream line is a factor in unhomogenized milk and holder pasteurization exposures of such milk should be kept below 145° F. to safeguard normal creaming. On the other hand, when the entire lot of milk is to be homogenized, which process disperses the fat, thus eliminating the cream layer, the pasteurization temperature may be markedly increased, resulting in greater pasteurization efficiency and at the same time having no deleterious effect on the flavor of the milk.

The homogenizing temperature employed was usually that of pasteurization, no advantage apparently being gained by precooling slightly in the vat before homogenizing. In those plants in which the milk was first homogenized and then pasteurized the milk was homogenized at a temperature below pasteurization, ranging from 130 to 145° F., pasteurization temperatures being from 143° F. to 150° F. respectively. When the milk was homogenized at 130° F. prior to pasteurization, the temperature of the milk was raised at once to that of pasteurization, the milk passing directly from the homogenizer, which raised the temperature a few degrees, to a barrel heater and then to the holder.

Probably the ideal sequence of processing homogenized milk would be one in which homogenization was accomplished prior to pasteurization. However, such a system has its limitations, such as the amount and percentage of milk to be homogenized and the facilities for preheating or subsequent heating of the milk to temperatures satisfactory for dispersing the fat, yet inhibiting the development of rancidity. Obviously, when only a part of a vat of milk is to be homogenized, the remainder being bottled as unhomogenized milk, homogenization must be done following pasteurization. Such is the case in many of the smaller plants. Consequently, many plants have no alternative other than homogenizing after pasteurization. With the introduction of the sanitary features of the modern homogenizer, which may be completely disassembled for washing and sanitizing, homogenization may be accomplished following pasteurization without significant contamination of the product.

Experimental

Inasmuch as sequences of processing involving homogenization are fairly flexible, trials were run, varying the temperature of homogenization prior to pasteurization in order to ascertain the effects on some properties of the milk.

Effect of the Temperature of the Milk at Time of Homogenization on the Dispersion of the Fat—Studies were made to determine the efficiency of homogenizing milk at various temperatures when the milk had been previously stored at 40° F. Samples of normal mixed raw milk were cooled to 40° F. and held for 24 hours to solidify the majority of the fat globules. Portions of the milk were then heated rapidly to temperatures of 40, 60, 80, 100, 120 and 140° F. and homogenized immediately upon reaching the desired temperature, using a

pressure of 5,000 pounds per square inch. It is recognized that such a pressure would likely never be used commercially, but it seemed desirable to ascertain what effect such a pressure would have upon the fat globules when they were in a solid state; thus, the investigator might be able to predict if milk could be handled rigorously (as in pumping) in certain temperature zones without accelerating the development of rancidity. This high pressure flashed the temperature of the milk approximately 17° F. Although the samples of homogenized milk were cooled immediately, the rise in temperature resulting from homogenization might have suppressed or accelerated lipolysis slightly at some of the temperatures employed.

The effect of the temperature of homogenization on the dispersion of the fat globules is illustrated in Fig. 1 (see insert in center spread). Little or no dispersion of the fat globules occurred until the fat approached a liquid state. Consequently, when the milk was homogenized at 40° or at 60° F. no evidence of homogenization as examined microscopically was noted. However, when the milk was homogenized at 80° F., which is well under the average melting point of milk fat, effects of homogenization could be observed. Although the homogenizing effects were noted at this temperature, satisfactory dispersion of the fat globules did not occur until the milk was homogenized at 100° F., a temperature well above that of the average melting point of milk fat. Homogenization of the milk at 120° F. and at 140° F. did not show marked improvement over that observed at 100° F. although there appeared to be a further slight decrease in the size of the fat globules with increases in temperature. These observations are essentially the same as the findings of Whitaker and Hilker (1937) who reported as follows: "At 80° there was a slight subdivision and at 100° F. more noticeable subdivision was noted. At 120 and 145° F. the globules were very small."

Effect of Re-homogenizing Milk at 40° F.—Inasmuch as no dispersion of the fat globules appeared to occur when the milk was homogenized at 5,000 pounds pressure at 40° F., as viewed under the microscope,

Table 2. The creaming of raw milk homogenized at 5,000 pounds pressure at 40° F.

Times homogenized at 40°F.	Cream layer after 24 hours on milk homogenized at 5000 pounds at 40°F. when	
	raw	subsequently pasteurized at 142°F. 30 min.
	per cent	per cent
0.....	14	14
1.....	5	5
2.....	5	5
3.....	5	5
4.....	5	5
5.....	5	5

and because no lipolysis resulted from this treatment, as will be discussed later, a sample of milk previously held 24 hours at 40° F. was homogenized five times at 40° F. using 5,000 pounds pressure. The high pressure used resulted in an increase in temperature of 17° F. so that the milk had to be cooled each time of homogenization before repeating the process. Photomicrographs of the milk are shown in Fig. 2 (see insert in center spread). Dispersion of the fat globules by this rigorous treatment was not accomplished even when repeated five times. Furthermore, no rancidity was detectable organoleptically and no increases in titratable acidity were observed even after 96 hours storage at 40° F.

Despite the fact that the fat globules were not dispersed by high-pressure homogenization at 40° F. the cream line was markedly reduced when the milk was homogenized once, but was not further reduced by repeated homogenization (Table 2). Fat tests of the upper and the lower 50 ml. portions of creaming cylinders of the milk showed that considerable fat rising did occur, as was evident also by the small cream layer showing a distinct line of demarcation.

Judging from the results of this rigorous treatment of milk, which is beyond the realm of practicality, it would appear that no homogenizing effects in milk would occur as a result of excessive agitation such as pumping, provided the milk were handled in the temperature zone from 40° to 60° F.

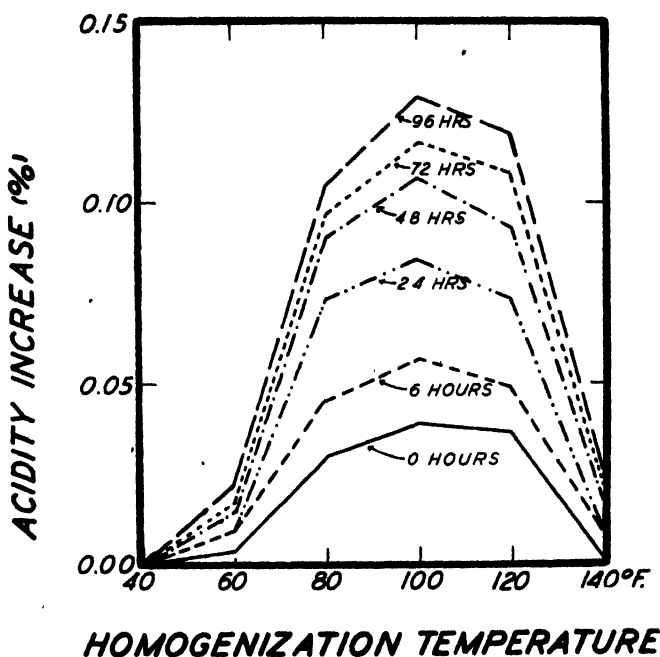


Fig. 3. Acidity increases in milk homogenized at 5,000 pounds at different preheating temperatures and stored at 40° F. for various periods.

Effect of the Temperature of the Milk at Time of Homogenization Upon the Development of Rancidity—The samples of milk homogenized at 40°, 60°, 80°, 100°, 120° and 140° F. and the samples re-homogenized at 40° F. were cooled immediately and held below 40° F. and examined organoleptically and titrimetrically for evidences of lipolysis. The data are presented in Figs. 1, 2, and 3.

The development of rancidity occurred in a temperature zone sufficiently high to liquify partially or soften the fat globules, yet low enough that the enzyme lipase was not inactivated. Under conditions of the study, major rancidity development occurred in the zone from 80° to 120° F. inclusive. Undoubtedly, if raw milk were homogenized at a few degrees below and above this temperature range some lipase activity would have been experienced. In fact, some acidity increase was noted upon storage in the samples heated momentarily and homogenized at 60° and 140° F. However, this range, 80° to 120° F., apparently is the most active zone for lipolysis as a result of homogenization.

These observations substantiate those previously reported. Doan (1933), heating raw milk momentarily and homogenizing at 100°, 110°, 120°, 130°, 140°, 150° and 160° F., found that the greatest development of rancidity occurred within the 100° to 130° F. zone and by extrapolation predicted that the enzyme lipase could be inactivated by flashing milk at 147° F.

Babcock (1934) found that the temperature range from 30° to 40° C. (86° to 104° F.) was the optimum homogenizing temperature for the development of rancidity in raw homogenized milk. He found that when the milk was homogenized at temperatures ranging from 4.5° to 10° C. (40° to 50° C.) that it had a good flavor for 18 hours, but developed an abnormal flavor upon further aging. When the milk was homogenized at 15° and 55° C. (59° and 131° F.) a slight rancid flavor developed; that homogenized at 20°, 25°, and 45° C. (68°, 77°, and 113° F.) developed the rancid flavor at the end of 18 hours, but to a lesser degree than the milk homogenized within the temperature range from 30° to 40° C. (86° to 104° F.). Whitaker and Hilker (1937) observed rancidity development when milk was preheated and homogenized at 80°, 90°, and 100° F., but did not note rancidity development with similar treatments at 120° F. Gould (1940) showed that raw milk heated momentarily and homogenized at 70°, 105°, 115°, 125°, 135°, and 145° F. underwent lipolysis in every case, the greatest lipolytic activity occurring in the temperature zone of 105° to 125° F. inclusive, and very little at 70° and at 145° F.

Repeated high-pressure homogenization was found to be ineffective in inducing lipolysis in raw milk held 24 hours at 40° F. When the milk was homogenized at 5,000 pounds at 40° F. or re-homogenized five times under those conditions, evidences of rancidity were not observed at 96 hours (Fig. 2). Even when 50-per cent mixtures of this and other milk were made, evidence of activation of lipase by repeated homogenization above that normally existing in raw milk could not be demonstrated (Table 3). Only when the raw milk was added to homogenized pasteurized milk was rancidity noted, but that homogenized five times was not more effective in inducing lipolysis than the same milk unhomogenized. The lipolytic activity of such

Table 3. The effect of repeated homogenization of raw milk at 40° F. development of rancidity.

Times homogenized at 5000 lb.	Rancidity development in milk when											
	Not mixed with other milk (Control)				Mixed with pasteurized milk which was							
					Unhomogenized				Homogenized			
	0 hours	24 hours	48 hours	72 hours	0 hours	24 hours	48 hours	72 hours	0 hours	24 hours	48 hours	72 hours
0.....	-	-	-	-	-	-	-	-	-	++	++	+++
1.....	-	-	-	-	-	-	-	-	-	++	++	+++
2.....	-	-	-	-	-	-	-	-	-	++	++	+++
3.....	-	-	-	-	-	-	-	-	-	++	++	+++
4.....	-	-	-	-	-	-	-	-	-	++	++	+++
5.....	-	-	-	-	-	-	-	-	-	++	++	+++

mixture has been demonstrated previously by Gould and Trout (1939) and by Larsen, Trout, and Gould (1941).

Effect of Pasteurization on the Increase in Titratable Acidity and Development of Rancidity Resulting from the Homogenization of Raw Milk—As previously discussed, an immediate increase in titratable acidity is observed when raw milk is homogenized within a certain temperature zone, the extent of increase depending chiefly upon the pressure used. Samples of homogenized raw milk were holder-pasteurized within five minutes of homogenization and after cooling were examined for titratable acidity. The data are presented in Table 4.

Table 4. The effect of pasteurization on the increase in titratable acidity resulting from the homogenization of raw milk.

Trial	The titratable acidity of milk immediately after processing		
	Control	When homogenized raw at 100°F. and	
		Unpasteurized	Pasteurized at once
	Percent	Percent	Percent
1.....	0.155	0.170	0.165
2.....	0.150	0.160	0.165
3.....	0.145	0.160	0.165
4.....	(Lost)	0.175	0.175
5.....	0.185	0.195	0.205
6.....	0.165	0.190	0.190
7.....	0.170	0.190	0.200
8.....	0.190	0.205	0.200
Average.....	0.166	0.181	0.183

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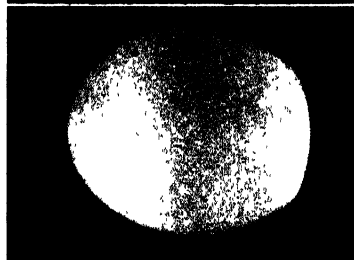
Hatching Ability of Poultry—By E. W. Henderson

(Pages 118 to 122)

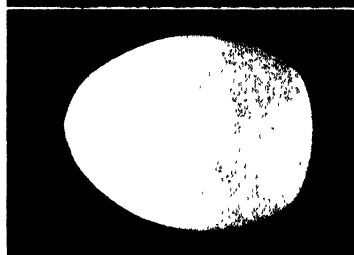
Fig. 1. Differences in egg shell texture score as seen before a candle.



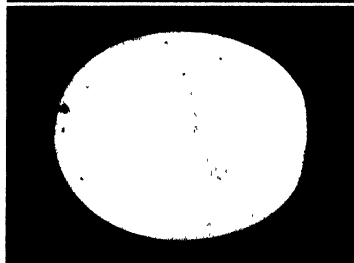
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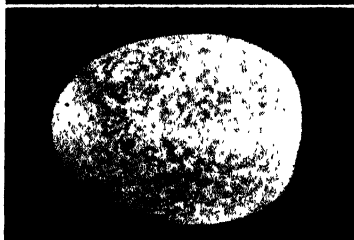
Score 2



Score 3



Score 4



Score 5

The Influence of the Time and Temperature of Homogenization on Certain Properties of Milk

By G. M. Trout and M. V. Scheid

(Pages 122 to 131)

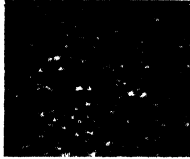
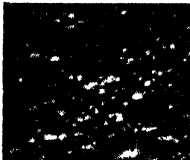



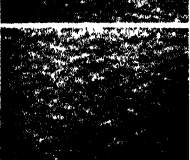
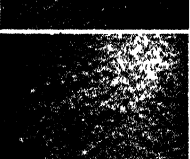
Temperature of homogenization (°F.)	Fat globules (x454)	Rancidity after				Acidity (%) after			
		0 hr.	2 hrs.	6 hrs.	24 hrs.	0 hr.	2 hrs.	6 hrs.	24 hrs.
Control. . . .		—	—	—	—	0.191	0.197	0.191	0.191
40.		—	—	—	—	0.191	0.197	0.191	0.191
60.		—	—	—	—	0.195	0.200	0.20	0.20
80.		?	++	+++	+++	0.227	0.233	0.243	0.270
100 ..		?	++	+++	+++	0.230	0.243	0.248	0.275
120.. . . .		?	++	+++	+++	0.228	0.243	0.240	0.264
140.		—	—	—	—	0.193	0.200	0.200	0.200

Fig. 1. The effect of temperature of homogenization (5,000 pounds pressure) on the dispersion of the fat globules and upon the development of rancidity.

*The Influence of the Time and Temperature of Homogenizing on
Certain Properties of Milk (Cont'd)*

(Pages 122 to 131)



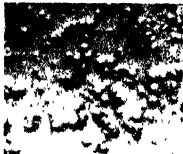


Times homogenized at 5000 lb. at 40°F.	Fat globules (x454)	Rancidity after			Acidity (°C) after		
		6 hrs	24 hrs.	96 hrs	6 hrs.	24 hrs.	96 hrs.
0		—	—	—	0.18	0.18	0.18
1		—	—	—	0.18	0.18	0.18
3		—	—	—	0.18	0.18	0.18
4		—	—	—	0.185	0.19	0.18
5		—	—	—	0.18	0.18	0.18

Fig. 2. The effect of rehomogenization of milk at 5,000 pounds pressure upon the dispersion of the fat and upon the development of rancidity when the fat globules were in a solid state.

Strength Properties of Chinese Elm Grown in Michigan

By A. J. Panshin

(Pages 115 to 117)

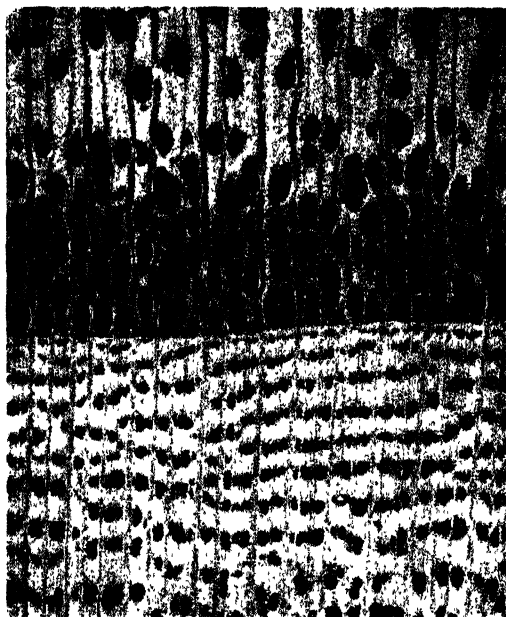


Fig. 1. Cross section of Chinese elm (Ulmus pumila L.) wood (12x). Spring wood is visible in the upper half, and the summer wood of the preceding ring, in the lower half of the photograph.

When the milk was pasteurized immediately after homogenization the further development of acidity was arrested, but the increase in acidity already noted was not eliminated. Apparently, therefore, if milk is homogenized prior to pasteurization within the lipase active zone, an increase in the titratable acidity above that present in similar milk unhomogenized might be expected. As shown by Gould (1940) this immediate increase in acidity is markedly less when the raw milk was homogenized at 135° F. Data presented in Fig. 3 would indicate also that as the temperature approached 140° F. the immediate increase in acidity upon homogenization is not so great.

What effect this increase in acidity has upon the flavor of the pasteurized product has not been established by experimental evidence. Some workers believe that accompanying this increase in acidity may be a slight enhancement of the flavor, imparting to the milk a certain "fullness" or "freshness" of flavor as contrasted to a lacking of or flatness of flavor in the unhomogenized milk, particularly during the late winter months. However, the beneficial effect on flavor is debatable and may not be justified by the risk of rancidity development involved should a delay in pasteurization be encountered. It must be borne in mind that unless the homogenized raw milk is pasteurized at once, it may definitely become rancid and undrinkable within a short time, depending upon the temperature of homogenization.

Several trials were run to ascertain the effect on flavor of homogenizing raw milk, followed immediately by pasteurization as compared with that obtained when the milk was homogenized after pasteurization. In these trials, the raw milk was homogenized at 100° F., a temperature giving maximum lipolysis, and at 130° F., a temperature at which the action of lipase is retarded. The data are presented in Tables 5 and 6.

From these results it would appear that no material advantage so far as flavor is concerned is attainable by homogenizing prior to pasteurization or vice versa. However, a temperature of 130° F. at which to homogenize involves less risk from rancidity development should there be a delay in pasteurization.

Table 5. The flavor score and criticism of milk homogenized raw at 100° F. at 2,500 pounds pressure and then pasteurized compared with that of milk homogenized after pasteurization. (Av. 3 trials.)

Treatment of sample	Flavor score and criticism of milk at					
	1 hour		24 hours		72 hours	
	Score	Criticism	Score	Criticism	Score	Criticism
1. Control raw.....	28.0	—	22.8	—	22.8	—
2. Homogenized raw.....	21.8	V. sl. rancid	13.0	Rancid	12.0	Rancid
3. Homogenized raw, pasteurized at once.....	22.7	—	22.8	—	22.7	—
4. Pasteurized.....	28.0	—	22.8	—	22.8	—
5. Pasteurized, homogenized.....	22.8	—	22.8	—	22.0	—

Table 6. The flavor of milk homogenized raw at 130° F. and then pasteurized compared with that of milk homogenized after pasteurization.

Trial	Flavor criticism at 24 hours when the milk was			
	Homogenized raw and		Pasteurized	
	Unpasteurized	Pasteurized	Unhomogenized	Homogenized
1.....	V. sl. rancid	—	—	—
2.....	V. sl. ra ncid	—	—	—
3.....	V. sl. rancid	—	—	—
4.....	V. sl rancid	—	—	—
5.....	V sl rancid	—	—	—

In scoring the samples of milk homogenized raw at 100° F., two experienced judges were asked to name their preference of two samples, one homogenized raw and then pasteurized immediately and the other pasteurized prior to homogenization. After some deliberation, they chose the latter, stating that the former did not clear up so well after tasting. No such comments were made when the homogenizing temperature of 130° F. was used.

In connection with the effect of time of homogenization on the flavor, Hood and White (1934) stated, "Practical experience and laboratory investigations have shown that a better flavoured milk is obtained with less likelihood of off flavours developing when the homogenization process takes place immediately after pasteurization and at the pasteurization temperature." They were particularly concerned with off flavors developing should a delay occur in retarding the activity of the enzyme lipase. On the other hand, Whitaker and Hilker (1937) obtained a good flavor when homogenized raw milk at temperatures ranging from 80° to 120° F. and pasteurizing immediately.

Summary

Several sequences of processing milk involving homogenization are possible. In 4 of 23 Michigan milk plants surveyed, the milk was homogenized prior to pasteurization at temperatures ranging from 130 to 145° F. The homogenization pressures employed were usually 2,500 pounds but ranged from 2,000 to 3,000 pounds. Temperatures of pasteurization of homogenized milk ranged from 143° F. for 30 minutes to 160° F. for 20 minutes.

Studies were made on the effect of homogenizing at various temperatures raw milk previously held 24 hours at 40° F. on the dispersion of the fat; on titratable acidity increases; and on the development of rancidity. The milk was homogenized at 5,000 pounds pressure at 40°, 60°, 80°, 100°, 120°, and 140° F. Complete dispersion of the fat, as revealed by microscopic examination, did not occur at the temperatures employed until a temperature of 100° F. was reached at which the milk fat was in a liquid state. Marked acidity increases were noted when raw milk was homogenized at 80°, 100°, and 120° F., but very

slight acidity increases were observed at 60° and 140° F. and none at 40° F.

Re-homogenization of raw milk five times at 40° F. using 5,000 pounds pressure failed to disperse the fat, to increase the titratable acidity, or to alter the flavor even after 96 hours storage. However, this rigorous treatment markedly decreased the cream layer which was not restored by subsequent pasteurization. Such treatment is out of the realm of possibility in commercial practice, but the results do indicate that raw milk stored overnight at 40° F. may undergo rigorous treatment at this temperature as in pumping or clarifying without inducing lipolysis.

Pasteurization of milk homogenized raw at 100° F. prevented the development of rancidity, but did not reduce the slight increase in titratable acidity resulting from the homogenization process. The slight increase in acidity which was not eliminated by pasteurization, had no perceptible effect on the flavor one way or the other. When milk was homogenized raw at 130° F. and immediately pasteurized, no harmful flavor effects were noted. Unless lipase was inactivated it soon rendered homogenized milk unpalatable, the extent of which depended upon the temperature and pressure of homogenization prior to pasteurization.

Whether to homogenize milk prior or subsequent to pasteurization would seem to depend primarily upon whether the entire vat of milk was to be homogenized. If part of the vat of milk were to be bottled as unhomogenized milk, then there is no alternative but to homogenize after pasteurization. When milk is homogenized before pasteurization, facilities must be had for preheating the milk to a homogenizable temperature and for immediate subsequent heating for the purpose of inactivation of the enzyme lipase, or preheating to such a temperature that the enzyme is practically inactivated at time of homogenization.

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FARM BUSINESS SUMMARY, MICHIGAN, 1940

C. O. MAY AND J. C. DONETH*

SECTION OF FARM MANAGEMENT

Earnings of farm account cooperators for Michigan were about the same in 1940 as in 1939. Labor incomes for 1940 averaged \$787 per farm based on 1,263 records distributed throughout the state. A total of 1,405 records were summarized by the college for 1940, but 142 were omitted from the summary reports because they were not comparable or for some other good reason.

The labor income represents what the operator has left for his labor and management after paying all cash operating expenses, allowing for depreciation and other inventory losses, charging for family labor (at hired wage rates) other than for the operator, and deducting 5 per cent interest on the investment. This earning figure does not give the farm credit for the value of the home-grown farm produce used by the household.

Procedure Followed

The farm account books are started between January 1 and April 1, depending on the area of the state. In the summer the farmer receives a farm visit by a farm management specialist and the local county agricultural agent, who assist him in keeping the book. At the close of the year (one year after starting), the record book is carefully checked by a representative of the Farm Management Department in the presence of the farmer-cooperator and brought back to the college. The book is closed and summarized for the farmer by the Farm Management Department and is then returned to the farmer.

The records are then studied by areas because there is a great variation in conditions throughout the state (Fig. 1). A "Farm Success Factor" report for each area is prepared, based on the farm account books kept in the area for the year. Each cooperator receives a copy of the report showing the figures for his farm business compared with those of the other farmers in the area. Also, each cooperator who has been in the project less than 6 years receives a summer visit by the specialist and county agricultural agent. At the time

*The Farm Management Section of the Michigan Agricultural Experiment Station, E. B. Hill and H. A. Berg of the Farm Management Department, and the county agricultural agents in 76 counties assisted with this project.

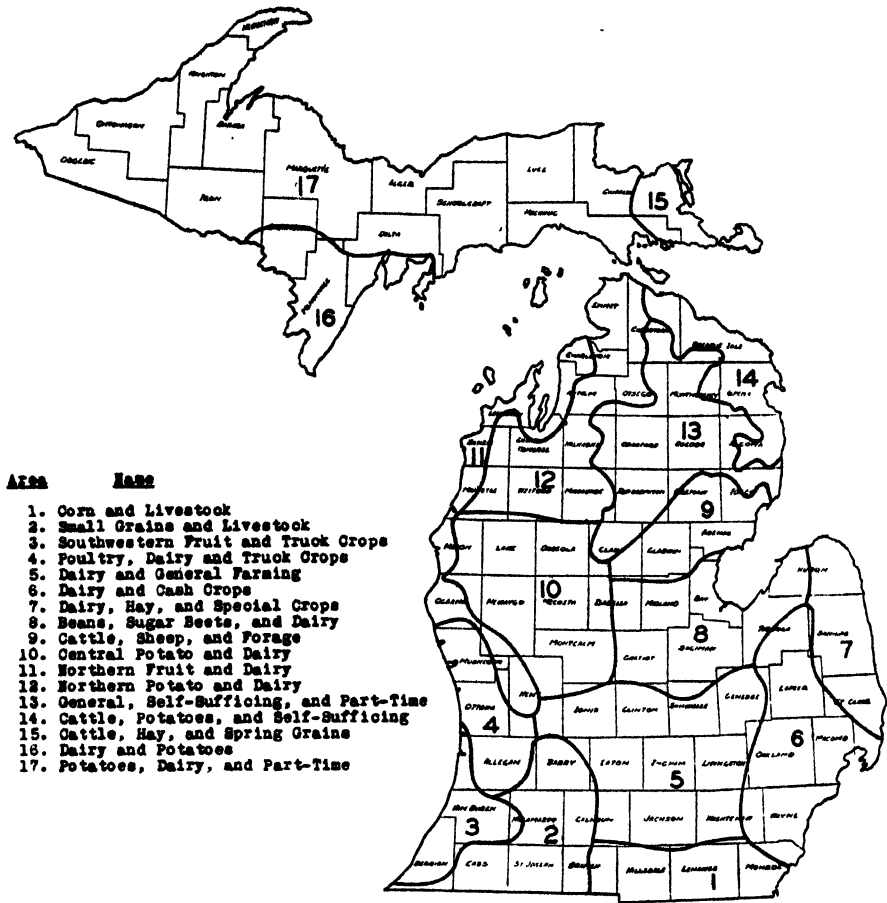


Fig. 1. The Seventeen Type-of-Farming Areas in Michigan.

of this visit the strong and weak points in the farm business are discussed, thus providing the farmer with a basis for making needed adjustments in order to improve his farm income.

The Economic Situation in 1940

The general price level of farm products averaged higher in 1940 than in 1939. According to the Economics Section of the Michigan Agricultural Experiment Station, the prices received by Michigan farmers for 20 major farm products rose from an index of 97 in 1939 to 106 for 1940. On the other hand, the index of farm costs rose only 2 points, from 113 to 115. Hence, the ratio of prices received to farm costs for Michigan rose from 86 in 1939 to 92 in 1940. For the United States as a whole, prices did not rise this much relative to costs, thus

Table 1. Comparison of prices of farm products and costs in Michigan in 1940* (1910-14 = 100)

ITEMS SOLD	Index numbers	COST ITEMS	Index numbers
Dairy products	115	Feed	100
All meat animals	113	Farm machinery	153
Hogs	76	Fertilizer	97
Beef cattle	134	Farm building material	149
Veal calves	140	Equipment	110
Lambs	140	Seed	130
Wool	152	Farm taxes	83
Chickens	126	Farm interest payments	97
Eggs	86	Farm wages	123
Feed crops	71		
Cash crops	102		
All farm products	106	All farm costs	115

*Data obtained from Orion Ulrey, Economics Section, Michigan Agricultural Experiment Station

Michigan farmers enjoyed a more favorable position than the average of the farmers in other states for 1940.

A comparison of prices received for farm products and prices paid by farmers in Michigan as compared with the base period 1910-14 is shown in Table 1.

The total income from livestock was higher in 1940 than in 1939. This was largely due to having more livestock, especially cattle, and also obtaining slightly greater returns per unit of livestock. The prices received for dairy products were improved over those of 1939 and cattle prices remained good. The corn-hog ratio was unfavorable for producers of pork. Poultry meat and egg prices remained low relative to feed costs. Mutton prices were only slightly better, but wool brought considerably more than in 1939.

The total income from crops was lower in 1940 than in 1939. The yields of some crops were better, especially for small grains and hay. However, corn and bean yields averaged lower in 1940. Sugar beet and potato yields were about the same both years. The price of potatoes and the prices of most feed crops, except corn, were lower than in 1939. Bean and sugar beet prices were about the same both years. As for fruit, the apple, peach, and pear crops were small and prices were better than for the year before. There was another big cherry crop in Michigan, but a smaller crop for the country as a whole resulted in higher prices than in 1939. The yields of grapes remained about the same and the price remained low.

The total expenses per farm averaged somewhat higher in 1940. A little more machinery was purchased than in 1939. The expenses for operating equipment, purchase of feed and hiring of labor ran a little higher in 1940.

Farm Investments

The capital investments averaged \$13,638 per farm for the 1,263 farms included in this report. Table 2 shows the various investment items and the amount and percentage that each item is of the total investment.

Table 2.—Average capital investment per farm on 1,263 Michigan farms in 1940.

Item	Capital per farm	Percent of total
Land	\$ 5,176	38
Improvements (less house)	3,508	26
Livestock	1,843	13
Machinery	1,574	12
Feed, crops and supplies	1,076	8
Orchard	461	3
TOTAL	\$13,638	100%

Farm Receipts

The total farm receipts averaged \$3,110 per farm in 1940. Table 3 shows the total receipts and the relative importance of the different items.

Table 3. Total receipts per farm on 1,263 Michigan farms in 1940.

Item	Receipts per farm	Percent of total
Cattle	\$ 418	13
Hogs	207	7
Sheep and wool	117	4
Poultry and eggs	269	8
Dairy products	1,039	33
Crops	775	25
Government payments	116	4
Labor off farm	116	4
Miscellaneous	53	2
TOTAL	\$3,110	100%

Farm Expenses

The total expenses averaged \$2,173 per farm in 1940. Table 4 shows the various expense items and the amount and percentage that each item is of the total expenses.

Variation in Individual Incomes

Individual farm incomes vary greatly under the same price conditions (Fig. 2). Many of the factors causing the great variation in earnings on farms for any one year are partially or entirely under the

Table 4. Total expenses per farm on 1,263 Michigan farms in 1940.

Item	Expenses per farm	Percent of total
Operator's labor.....	\$ 532	24
Family labor.....	220	10
Hired labor.....	270	13
Total labor.....	\$1,022	47
Machinery.....	344	16
Improvements.....	141	6
Feed purchases.....	278	13
Crop expenses.....	212	10
Taxes.....	78	4
Miscellaneous.....	98	4
TOTAL.....	\$2,173	100%

control of the farmer. Such factors as size of business, soil management, cropping program, livestock program, combination of enterprises, efficiency in the use of labor and capital and effective marketing are some of the factors over which the farmer can exercise considerable control.

This state summary report is not designed to try and explain the differences between successful and unsuccessful farms. That type of information is presented in the annual "Farm Success Factor" reports for each of the different type-of-farming areas.

The percentage of farms in the different income groups fluctuates from year to year with the fluctuation in the average earnings of all farms. Table 5 shows this year-to-year change.

What causes this year-to-year variation in farm earnings? Changes in farm organization, management, variations in crop yields and ani-

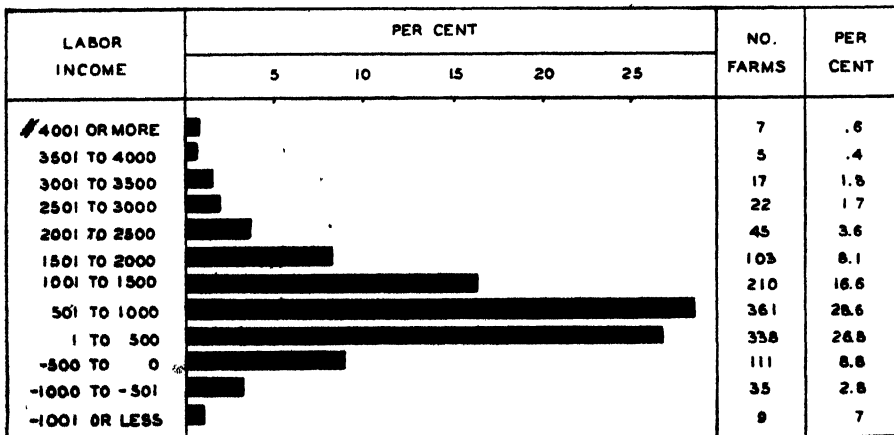


Fig. 2. Distribution of labor income on 1,263 Michigan farms, 1940.

Table 5. Percentage distribution of labor incomes by years—1929-40.

Year	Number of farms	Percent of farms in each labor income group		
		\$0 or less	\$1 to \$1,000	\$1,001 or more
1929.....	427	23%	52%	25%
1930.....	771	62	32	6
1931.....	925	83	16	1
1932.....	831	87	12	1
1933.....	795	35	55	10
1934.....	845	21	56	23
1935.....	933	13	56	31
1936.....	1,055	6	43	51
1937.....	1,163	22	54	24
1938.....	1,252	20	57	23
1939.....	1,348	14	54	32
1940.....	1,263	12	55	33
12-Year Average.....	967	31%	46%	23%

mal production are important factors which help to explain the variations on individual farms. The most important factor, however, which causes this year-to-year variation in the average earnings of all farms is the relation of prices received by farmers to farm costs. When the general price level changes, the prices of basic commodities, such as wheat, corn, pork, butter, and wool change quickly under unregulated circumstances. Many costs of operating a farm cannot be adjusted so quickly. Wages, taxes, debts, retail prices, and overhead costs change less rapidly. Therefore, farmers are benefited by a moderate rise in prices, but are adversely affected by a fall in prices. That the course which commodity prices take and the adjustment of farming costs to them has an important influence on farm incomes is shown in Fig. 3.

Change in General Level of Farm Incomes

Farm earnings vary greatly from year to year. This is shown by a large number of farm records kept by farmers during each of the last 12 years, 1929-40, in cooperation with the Farm Management Department of Michigan State College (see Table 6). As an average, farm earnings were "in the red" for each of the years 1930 to 1932, showed gradual improvement from 1933 to 1936, and averaged about the same in 1937 and 1938 as in 1934. Except for 1936 the earnings in 1939 and 1940 were higher than for any of the 10 preceding years.

State and Area Averages

The accompanying tables 7, 8, 9 and 10 indicate that farm earnings vary considerably between different types-of-farming areas in any one

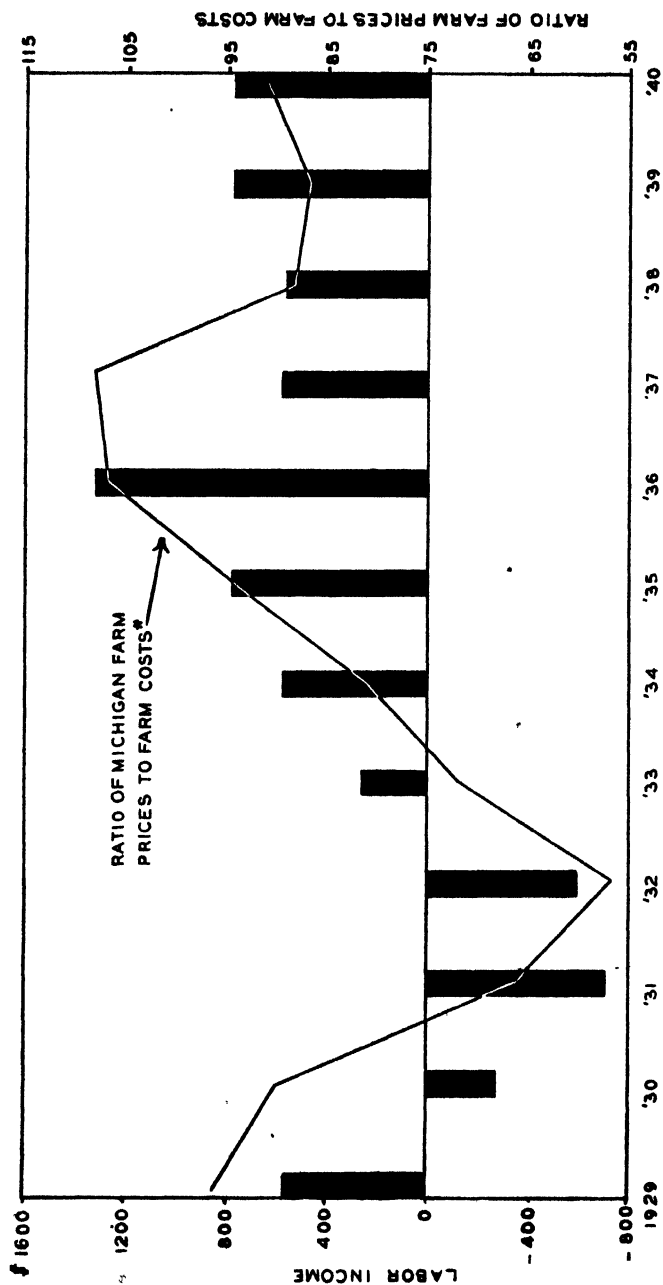


Fig. 3. Relationship between the ratio of Michigan farm prices to farm costs and labor incomes, 1929-40.

Table 6. Twelve-year comparison of financial returns on Michigan farm-account farms, 1929-40.

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	12-year average
Number of farms	427	771	925	831	785	845	933	1,055	1,163	1,252	1,346	1,263	967
Total acres	159	162	163	156	154	157	164	161	158	163	165	170	161
Tillable acres	107	111	109	103	98	103	107	106	104	108	108	112	106
Average investment	\$16,990	\$17,264	\$15,859	\$12,974*	\$11,813	\$12,192	\$12,510	\$12,502	\$12,904	\$13,024	\$13,150	\$13,638	\$13,734
Cash receipts	\$ 3,690	\$ 3,373	\$ 2,299	\$ 1,805	\$ 1,825	\$ 2,389	\$ 2,826	\$ 3,353	\$ 3,353	\$ 2,989	\$ 3,195	\$ 3,502	\$ 2,894
Cash expenses	2,351	2,128	1,487	1,068	1,000	1,324	1,068	1,969	2,101	1,841	1,926	2,135	1,743
Net cash income	\$ 1,339	\$ 1,245	\$ 812	\$ 717	\$ 825	\$ 1,065	\$ 1,158	\$ 1,484	\$ 1,257	\$ 1,148	\$ 1,269	\$ 1,367	\$ 1,141
Net change in inventory	354	—430	—520	—524	153	252	398	650	155	284	386	322	123
FARM FAMILY INCOME	\$ 1,693	\$ 815	\$ 292	\$ 193	\$ 978	\$ 1,317	\$ 1,556	\$ 2,134	\$ 1,412	\$ 1,432	\$ 1,655	\$ 1,689	\$ 1,264
Less: Unpaid family labor	259	215	175	139	138	142	166	191	198	210	218	220	189
NET FARM INCOME	\$ 1,434	\$ 600	\$ 117	\$ 54	\$ 840	\$ 1,175	\$ 1,390	\$ 1,943	\$ 1,214	\$ 1,222	\$ 1,437	\$ 1,469	\$ 1,075
Less: Operator's labor	671	697	546	423	420	418	432	538	528	528	525	532	519
Return for investment and management	\$ 763	\$ — 67	\$ — 429	\$ — 369	\$ 420	\$ 757	\$ 958	\$ 1,405	\$ 686	\$ 694	\$ 912	\$ 937	\$ 556
BATE EARNED ON INVESTMENT, PERCENT	4 49	— 39	—2 70	—2 94	3 56	6 21	7 66	11 24	5 32	5 33	6 94	6 87	4 31
NET FARM INCOME	\$ 1,434	\$ 600	\$ 117	\$ 54	\$ 840	\$ 1,175	\$ 1,390	\$ 1,943	\$ 1,214	\$ 1,222	\$ 1,437	\$ 1,469	\$ 1,075
Less: Interest at 5%	849	863	793	649	591	610	626	625	645	651	637	682	687
LABOR INCOME	\$ 548	\$ —263	\$ —676	\$ —595	\$ 249	\$ 565	\$ 764	\$ 1,318	\$ 569	\$ 571	\$ 780	\$ 787	\$ 388

*Land inventory values on farm accounting farms were reduced approximately, 25 percent when the 1932 farm account books were summarized by this Department.

Table 7. Financial summary of 1,263 Michigan farms by type-of-farming areas—1940.

Type-of-Farming Area	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,263	90	118	43	67	210	73	33	121	65	112	47	121	39	20	34	67
Total acres	170	175	196	89	119	179	168	209	140	188	181	120	188	207	199	183	188
Owned.....	80	70	75	85	83	73	69	85	69	81	82	63	83	89	93	84	92
Percent of farm area tillable.....	66	76	75	83	78	74	73	77	77	49	60	71	54	47	62	45	56
Tillable acres.....	112	133	147	74	83	133	123	161	112	93	109	91	101	97	123	69	56
Capital investments, total	\$13,633	\$16,386	\$16,386	\$12,452	\$12,452	\$16,441	\$15,870	\$17,226	\$16,413	\$11,137	\$15,007	\$8,874	\$8,874	\$8,766	\$9,712	\$9,418	\$7,816
Real estate (less houses).....	9,145	10,412	11,380	13,559	8,038	10,891	10,731	11,029	11,115	6,331	7,334	11,837	5,631	5,401	6,244	6,072	5,083
Machinery and equipment.....	1,674	1,835	1,644	1,775	1,442	1,735	1,679	2,121	1,912	1,242	1,356	1,727	1,222	1,316	1,206	1,520	1,304
Feed, crops and supplies.....	1,076	1,574	2,116	647	1,066	1,430	1,202	1,800	1,584	1,874	813	596	1,765	578	582	325	315
Livestock (includes horses).....	1,843	2,563	1,346	871	1,939	2,365	2,238	2,276	1,802	617	1,034	847	1,265	1,491	1,060	1,402	1,184
Cash Receipts, total	\$3,502	\$4,736	\$3,772	\$3,549	\$3,549	\$4,221	\$3,845	\$4,353	\$3,941	\$2,272	\$3,017	\$4,381	\$2,381	\$2,350	\$2,705	\$2,496	\$1,948
Livestock sales, total (includes horses).....	2,260	2,560	2,569	933	3,021	2,710	2,563	2,862	2,156	1,704	2,042	2,381	1,523	1,509	2,081	1,568	1,380
Crop sales.....	170	225	269	310	913	583	563	1,140	1,270	1,042	2,069	2,069	1,523	1,509	302	296	296
Government payments*.....	116	225	269	310	913	583	563	1,140	1,270	1,042	2,069	2,069	1,523	1,509	302	296	296
Labor off farm.....	116	102	93	89	116	102	93	127	127	67	94	78	117	146	110	157	137
Other receipts.....	240	274	283	217	162	206	293	324	262	170	211	203	203	138	128	160	231
Cash Expenses, total	\$2,133	\$2,904	\$2,480	\$3,040	\$1,063	\$2,578	\$2,316	\$2,603	\$2,105	\$1,368	\$1,940	\$2,699	\$1,392	\$1,405	\$1,406	\$1,419	\$1,411
Farm improvements.....	205	220	247	239	170	229	250	375	211	183	201	173	148	148	179	110	148
Livestock and equipment.....	694	599	771	739	575	801	808	1,040	745	505	642	788	510	594	451	517	645
Livestock purchases (includes horses).....	336	965	381	143	220	565	242	417	336	229	271	127	150	183	199	83	162
Feed bought.....	278	453	376	235	510	344	373	148	229	133	211	168	154	146	261	282	248
Hired labor.....	270	327	289	753	241	244	307	221	215	130	234	865	200	192	194	147	90
Crop expense.....	212	226	209	741	174	218	246	233	218	90	152	419	139	128	140	168	118
Taxes.....	78	111	111	81	74	94	95	89	85	58	158	280	51	138	53	48	31
Other expenses.....	72	94	96	109	88	83	95	80	66	40	61	70	40	45	51	64	39
Net Change in Inventory	\$322	\$247	\$407	\$509	\$197	\$402	\$473	\$230	\$198	\$319	\$390	\$469	\$68	\$200	\$163	\$283	\$365
Improvements (includes orchard).....	60	80	63	245	17	35	199	36	66	64	130	120	85	130	85	9	46
Machinery and equipment.....	161	35	201	153	137	219	203	328	180	112	169	208	190	133	95	91	186
Feed, crops and supplies.....	5	45	12	64	4	48	68	120	89	60	25	67	11	11	27	154	87
Livestock (includes horses).....	96	117	131	47	100	100	100	313	101	101	132	67	67	67	56	60	60
Net Cash Income	\$1,367	\$1,832	\$1,292	\$1,508	\$1,487	\$1,833	\$1,529	\$1,750	\$1,736	\$904	\$1,177	\$1,693	\$990	\$855	\$1,299	\$1,077	\$537
Farm inventory increase.....	322	247	407	509	197	402	473	230	198	319	390	469	68	200	163	283	365
Farm family income.....	1,689	2,079	1,690	1,992	1,694	2,035	2,002	2,370	1,924	1,123	1,577	2,151	1,033	1,055	1,432	1,330	923
Unpaid family labor.....	220	168	201	204	226	201	262	211	204	204	238	209	308	195	166	244	283
Net Farm Income.....	1,469	1,911	1,488	1,788	1,493	1,809	1,711	2,108	1,723	919	1,329	1,942	850	800	1,296	1,086	640
Less: Operator's labor.....	532	575	572	581	581	587	587	587	581	456	537	455	455	448	451	448	437
Rate Earned on Investment (percent).....	6.87	3.15	5.63	7.21	7.26	7.58	7.29	8.80	6.96	4.60	7.11	9.71	4.50	4.69	8.70	6.57	2.90
Net Farm Income	\$1,469	\$1,911	\$1,488	\$1,788	\$1,493	\$1,809	\$1,711	\$2,108	\$1,723	\$919	\$1,329	\$1,942	\$850	\$800	\$1,296	\$1,086	\$640
Less: Interest at 5%.....	682	819	819	843	824	822	763	861	821	503	557	750	439	439	439	439	439
Labor Income—1940.....	787	1,092	679	945	899	987	918	1,247	902	416	772	1,192	407	421	810	615	249
Labor Income—1939	780	1,053	920	500	768	902	865	1,762	1,225	480	764	568	620	430	811	569	289
Labor Income—1938	571	687	427	449	610	588	573	1,035	504	431	624	537	611	430	961	569	45

*Figures not comparable between areas because on some farms both 1939 and 1940 payments were received during 1940.

Table 8. Crops: Kinds and acreages of crops and also crop yields by type-of-farming areas—1940.

Type-of-farming Areas	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,293	90	119	43	57	210	73	33	121	65	112	47	121	39	23	34	67
Number of tillable acres	112	133	147	74	98	133	123	101	112	93	109	91	101	97	123	99	56
Percent tillable acres in hay, seed and pasture	46	42	43	29	42	42	40	42	32	55	51	35	35	61	63	56	66
Percent tillable acres in legumes*	36	38	36	29	31	33	35	35	28	42	43	33	36	51	38	38	40
Percent tillable acres in:																	
Tillage pasture	18	16	21	11	15	18	19	18	13	20	21	13	23	23	18	14	13
Alfalfa hay	16	15	13	9	13	15	17	13	14	25	18	13	20	25	9	18	11
Other hay	11	10	10	9	14	8	9	11	6	10	12	9	13	7	35	24	43
Corn	15	20	17	10	19	18	17	8	15	15	14	8	13	7	1	11	3
Wheat	7	10	11	3	10	10	7	8	7	3	4	3	3	3	3	2	—
Oats (oats and barley mixed)	11	12	8	5	15	13	14	12	12	12	10	6	8	10	12	12	11
Barley	2	2	1	1	2	2	3	5	7	2	1	—	—	3	4	9	7
Beans	4	—	1	—	1	4	2	14	14	5	4	2	1	—	0	—	0
Sugar beets	2	1	—	0	1	1	5	8	8	1	—	—	—	0	0	1	7
Potatoes	2	1	1	2	2	1	3	—	—	1	4	3	2	1	1	6	—
Fruit and truck	3	2	1	46	3	1	3	1	—	—	3	37	9	5	—	—	—
Other crops	9	11	16	4	5	8	5	5	5	5	9	7	11	15	17	3	6
Crop yields per acre																	
Alfalfa hay	1.9	2.1	1.9	2.0	2.1	2.0	2.1	1.9	2.0	1.8	2.1	1.7	1.6	1.6	1.8	2.0	2.0
Other hay	1.6	1.8	1.5	1.7	1.8	1.7	1.8	1.9	1.7	1.4	1.7	1.2	1.3	1.5	1.6	1.7	1.5
Corn for silage	7.4	8.6	9.2	6.3	7.5	7.4	7.5	7.3	7.9	6.8	6.7	7.9	6.7	7.3	—	1.1	7.1
Corn (shelled)	36	44	41	36	38	35	29	30	32	27	37	35	29	28	—	38	43
Wheat	26	23	22	27	26	27	26	31	33	22	27	26	25	21	22	28	17
Oats	50	60	43	50	45	54	55	59	62	41	43	48	35	45	39	44	31
Barley	34	29	24	24	33	33	40	40	41	33	27	31	31	28	23	35	24
Beans	14	6	11	—	10	12	12	13	18	11	11	15	11	17	—	10	—
Potatoes	132	97	122	89	97	93	92	104	111	103	125	144	161	129	180	186	173
Sugar beets	9.5	12.7	9.7	7.2	9.0	8.4	8.4	8.4	9.8	10.1	8.5	—	—	—	—	8.4	—
Crop yield index	100	111	98	108	105	102	102	106	113	87	96	90	85	87	96	107	93
Value crops produced per tillable acre	\$ 16.96	\$ 17.13	\$ 14.22	\$ 16.97	\$ 16.56	\$ 18.26	\$ 16.69	\$ 21.96	\$ 12.81	\$ 16.95	\$ 16.95	\$ 15.14	\$ 15.14	\$ 15.14	\$ 16.95	\$ 16.95	\$ 23.6
Crop sales	771	573	529	3,199	613	655	1,400	1,217	1,915	574	2,963	2,963	558	500	302	256	236
Government payments**	116	226	203	89	112	96	96	99	79	87	87	84	78	77	84	66	24
Feed bought	278	453	376	235	510	344	273	148	238	133	211	108	154	146	261	253	248

*Tillable land in tree fruits and vineyards is not included in the tillable acres in the computation of these factors.

**Figures not comparable between areas because in some areas both 1939 and 1940 payments were received during 1940.

Table 9. Livestock: Kinds, amounts, and returns from livestock by type-of-farming areas—1940.

Type-of-Farming Areas	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	1,283	90	118	43	67	210	73	33	121	65	112	47	121	39	23	34	67
Livestock income, total	\$2,051	\$2,844	\$2,384	\$ 869	\$2,732	\$2,567	\$2,636	\$2,509	\$1,956	\$1,597	\$1,941	\$ 982	\$1,367	\$1,319	\$1,982	\$1,903	\$1,294
Livestock income per tillable acre*	18 65	21 42	16 28	18 90	26 54	19 41	21 67	15 53	17 50	17 14	17 97	16 74	13 55	13 08	16 17	26 04	23 11
Productive animal units	24 0	34 5	29 0	9 2	23 7	30 2	25 2	27 0	22 9	26 0	22 7	11 8	17 9	19 8	19 3	18 8	17 8
Tillable acres per productive animal unit*	4 6	3 8	5 1	5 0	3 9	4 4	4 8	6 0	4 9	3 6	4 8	5 0	5 6	4 9	6 4	3 7	3 2
Cattle																	
Number of dairy cows	10 2	10 7	10 4	4 4	12 0	10 2	13 6	13 6	9 1	9 9	10 8	6 2	9 5	9 0	8 9	12 6	10 2
Dairy sales per cow	\$ 102	\$ 112	\$ 112	\$ 93	\$ 119	\$ 113	\$ 124	\$ 101	\$ 93	\$ 65	\$ 99	\$ 78	\$ 86	\$ 70	\$ 128	\$ 104	\$ 89
Dairy sales, total	1,039	1,199	1,166	415	1,432	1,151	1,677	1,379	849	640	1,075	498	820	628	1,141	1,310	908
Cattle income	418	479	452	162	436	516	503	749	417	490	429	223	303	351	322	299	237
Hogs																	
Number of sows	1 5	3 3	3 4	0 6	0 7	2 0	0 7	0 3	1 5	1 6	1 1	0 6	0 9	0 8	0 4	0 2	0 2
Number litters farrowed	2 5	6 2	6 1	1 0	1 2	3 4	1 0	0 4	2 6	2 7	1 7	0 8	1 3	1 2	0 6	0 3	0 3
Pigs weaned per litter	6 5	6 3	6 3	7 2	6 0	6 5	6 8	6 9	6 3	6 7	7 0	7 1	6 9	6 6	7 5	8 4	8 6
Hog income, total	\$ 207	\$ 507	\$ 499	\$ 64	\$ 113	\$ 301	\$ 90	\$ 33	\$ 242	\$ 199	\$ 157	\$ 70	\$ 85	\$ 82	\$ 31	\$ 27	\$ 12
Sheep																	
Number of ewes	10	14	11	—	—	25	10	6	8	21	5	—	5	8	9	—	—
Lambs raised per 100 ewes	95	89	100	—	—	91	98	94	105	92	98	—	80	120	114	—	—
Sheep income, total	\$ 117	\$ 288	\$ 109	\$ 13	\$ 15	\$ 295	\$ 108	\$ 54	\$ 91	\$ 148	\$ 42	\$ 9	\$ 31	\$ 88	\$ 109	\$ 0	\$ 3
Poultry																	
Number of hens	98	131	76	68	281	116	86	108	124	59	91	67	50	59	103	64	53
Egg sales per hen	\$ 2 10	\$ 1 99	\$ 1 83	\$ 2 22	\$ 2 45	\$ 2 02	\$ 2 35	\$ 2 41	\$ 2 23	\$ 1 57	\$ 1 97	\$ 2 10	\$ 1 59	\$ 1 85	\$ 2 74	\$ 2 40	\$ 2 12
Egg sales, total	208	261	140	152	614	234	204	280	277	92	179	141	80	109	282	154	112
Poultry income, total	298	371	188	195	735	324	258	282	350	120	237	189	128	170	377	167	133

*Tillable land in tree fruits and vineyards is not included in the tillable acres in the computation of these factors

Table 10. Expense and Efficiency Factors: Labor, machinery, improvement, and other costs by type-of-farming areas—1940.

Type-of-Farming Areas	All Farms	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number of farms	1 283	90	114	43	67	210	73	33	121	65	112	47	121	39	23	34	67	
Man Labor:																		
Number of men	1 9	1 9	2 0	2 6	1 8	1 9	2 1	2 0	1 8	1 7	1 9	2 6	1 8	1 8	1 8	1 7	1 8	1 8
Man labor cost, total	\$1 022	\$1 070	\$1 066	\$1 529	\$1 025	\$1 032	\$1 153	\$1 003	\$1 007	\$ 790	\$1 009	\$1 559	\$ 859	\$ 535	\$ 801	\$ 858	\$ 799	
Hired labor	270	327	289	753	241	244	307	221	215	130	234	865	200	192	184	147	80	
Charge for family help	220	168	201	204	201	226	291	262	211	204	238	209	208	195	166	244	282	
Charge for operators labor	532	575	576	372	553	562	555	590	581	456	537	465	451	448	451	467	497	
Man labor cost per tillable acre	9 06	8 04	7 23	29 76	11 00	7 74	9 35	6 60	9 01	5 46	9 29	17 13	9 50	8 60	6 53	12 39	14 24	
Power and Machinery:																		
Machinery cost, total	\$ 344	\$ 374	\$ 348	\$ 427	\$ 316	\$ 349	\$ 353	\$ 438	\$ 389	\$ 254	\$ 323	\$ 430	\$ 286	\$ 346	\$ 302	\$ 287	\$ 295	
Per tillable acre	3 06	2 81	2 36	5 50	3 39	2 63	3 12	2 72	3 48	2 72	2 97	4 73	2 83	3 57	2 46	4 14	5 25	
Percent farms using tractors	72	82	66	74	75	74	73	73	86	48	62	81	62	67	48	74	88	
Number of horses	2 5	2 7	3 1	2 0	2 3	2 9	3 0	2 8	2 3	2 7	2 4	1 5	2 2	2 0	2 5	1 9	1 1	
Improvements:																		
Net annual cost, total	\$ 141	\$ 171	\$ 185	\$ 145	\$ 145	\$ 180	\$ 158	\$ 151	\$ 158	\$ 102	\$ 123	\$ 118	\$ 90	\$ 89	\$ 85	\$ 96	\$ 86	
Per tillable acre	1 25	1 25	1 25	1 96	1 50	1 35	1 29	94	1 41	1 09	1 13	1 30	89	92	89	1 39	1 53	
Investment per annual unit	132	117	138	293	135	136	133	137	165	85	119	223	114	98	104	125	117	
Feed bought per tillable acre	\$ 2 47	\$ 3 40	\$ 2 55	\$ 3 19	\$ 5 47	\$ 2 58	\$ 2 22	\$ 92	\$ 2 04	\$ 1 43	\$ 1 94	\$ 1 84	\$ 1 53	\$ 1 50	\$ 2 13	\$ 4 07	\$ 4 43	
Crop expense per tillable acre	1 88	1 70	1 42	10 06	1 87	1 64	2 00	1 45	1 95	97	1 40	4 60	1 38	1 32	1 14	2 43	2 10	
Taxes per tillable acre	70	83	75	1 10	79	70	77	55	76	62	63	88	50	39	43	69	55	
Other expenses per tillable acre	88	89	86	1 25	1 32	86	1 20	77	92	64	86	68	65	65	45	1 32	96	
Gross income per tillable acre	\$27 65	\$28 98	\$22 67	\$90 65	\$35 16	\$26 85	\$29 38	\$23 44	\$39 78	\$20 89	\$25 51	\$47 18	\$20 23	\$21 19	\$20 75	\$35 37	\$32 68	
Total expenses per tillable acre	19 32	15 95	16 42	44 15	25 40	17 49	19 98	13 95	19 57	15 93	19 22	31 16	16 28	16 95	13 86	26 43	29 06	
Net income per tillable acre	8 33	10 03	6 25	16 50	9 76	9 36	9 40	9 49	10 21	4 96	7 29	16 02	3 95	4 24	6 89	8 94	3 62	
Expenses per \$100 income	70	65	72	73	72	65	68	60	66	76	71	66	80	80	67	75	89	

year. Also, the areas do not retain the same relative position in earnings year after year (see "Labor Income," Table 7). Factors beyond a farmer's control will cause changes in the relative position. These tables show percentages of tillable land in various crops, crop yields, livestock inventories, power and machinery costs, amounts of labor, and various other factors affecting farm earnings, as well as average income and expense figures.

BULLETIN REVIEWS

Spec. Bul. 309—The Competitive Position of Dairying in Michigan—Baumann, R. V. and Hill, E. B.—This bulletin reports a study designed (a) to provide information concerning the long-time outlook for dairying in Michigan and (b) to indicate the adjustments in production that will be desirable under each of several sets of conditions that may exist in the future. Particular emphasis is given to the effect of the soil conservation program on the competition of Michigan's dairy products with those of other areas. The available evidence suggests that the major Corn Belt States and more especially the transition areas at the margin of the Corn Belt will furnish the greatest competition in dairy production as far as Michigan producers are concerned.

The quantity of milk produced in Michigan has increased considerably in recent years, although milk prices relative to those of other farm products are not more favorable than formerly. Apparently the expansion of milk production has been made possible by certain changes in the crop and livestock systems followed. An increase in the total quantity of feed available has resulted from the wide adoption of alfalfa hay and recently the introduction of hybrid corn. In addition, dairy cattle numbers have increased, whereas the number of other kinds of livestock has decreased in recent years. As a consequence, a larger proportion of the feed produced in Michigan is now fed to dairy cattle.

A continuation of the present trend toward increased milk production is indicated from this study. This situation will probably hold true even though there are no increases in the prices of dairy products.

Considerably more milk is being consumed in Michigan now than 20 years ago. This increase in consumption has been associated with a marked increase in population and income per worker. (38 pp., 11 figs.)

Spec. Bul. 310—Marketing of Milk Products in Lenawee County, Michigan—Ulrey, O.—This study describes the local marketing structure and outlets for dairy products in Lenawee County, with special emphasis on competition in the area. It is one segment of a study of inter-regional competition in the production and sale of dairy products carried on by the agricultural experiment stations in the principal dairy regions, in cooperation with the United States Bureau of Agricultural Economics.

The area is located conveniently for trucking of fresh milk to the Detroit and Toledo markets, and for shipping of sweet cream to markets along the Atlantic coast. Five large manufacturing plants evaporate whole milk, which is distributed throughout the eastern part of the country. The condensaries also serve as surplus plants for the Detroit milk shed. The Michigan Producers' Dairy Company, a producers' cooperative organized and operated to handle surplus milk of the Detroit area, has its parent plant at Adrian.

The excessive competition among the various outlets for the milk of the area has resulted in duplications of country routes, excessive hauling, many small loads, and relatively high truck rates. Because of the locations and wide variety of milk outlets for the area, the production prices and marketing of milk has been affected by any changes in (1) demand for fluid milk in the metropolitan areas of Detroit and Toledo, (2) the eastern demand for sweet cream, (3) production costs in Lenawee County and in competing areas of evaporated milk and sweet cream, (4) the cost of transporting cream from the county and from the competing areas to the eastern markets, and (5) by the changes in the restrictions and inspection requirements of the eastern cream markets.

The inspection of both milk and cream in the area has been in a state of confusion. The principal problems are the lack of uniformity of requirements among outlets, different interpretations of the same regulations, and variation in strictness of enforcement among cities and states. It has been very difficult for the milk plants and patrons to comply with the numerous and frequently conflicting minor regulations of the eastern cream markets. (42 pp., 16 tables, 7 figs.)

Spec. Bul. 311.—Experience of Michigan Rural Banks with Short Term Loans to Farmers—Burroughs, R. J. and Patton, H. S.—This bulletin reports the findings of a survey of the note ledger accounts of 100 sample farm borrowers during the economic cycle 1928-37, at each of nine country banks located in different types of farming areas in Michigan, supplemented by replies to questionnaires returned by 110 rural banks through the Michigan Bankers Association. (Farm real estate mortgage loans were not included in this study.)

Information obtained from these sources is analyzed with a view to throwing light on such questions as the following:

(1) To what extent does the use of bank credit by Michigan farmers vary from season to season, and from year to year within the economic cycle?

(2) What are the practices of Michigan banks in respect to charges made for loans and renewals to farm borrowers, and to security required?

(3) For what amounts and for what purposes are bank loans most frequently made to Michigan farm borrowers, and how do these vary with different types of farm enterprise?

(4) How "liquid" are bank loans to farmers as measured by: (a) the proportion of loans which are repaid in full at note maturity dates; (b) the length of time loans remain outstanding and the number of note renewals involved?

(5) What relationships are to be found between "liquidity" of bank loans to farmers and such factors as: (a) the purposes to which loan proceeds are applied by borrowers; (b) the size of loans; and (c) the period in the economic cycle when loans originated?

(6) Are loans by country banks to farmers less liquid and accompanied by greater proportionate losses than loans to non-farm customers? (80 pp., 28 tables, 3 figs.)

JOURNAL ARTICLE ABSTRACTS

Relationship Between Organic Matter Content and Moisture Constants of Soils—Stone, J. T. and Garrison, C. S.—*Soil Science*. 50 (4): 253-256. 1940. [Journal Article 451 (n.s.) from the Mich. Agri. Exp. Sta.]—Few data showing the effect of different contents of organic matter on the moisture relationships of soils have been available. Samples were collected from under the sod along old, established fence rows and a few feet away in fields where customary soil management practices had been followed. This system of sampling permitted of comparison between soils differing only in organic matter content. The samples included three loamy sands, nine sandy loams, eight loams, two silt loams, one clay loam, one loamy fine sand, and one fine sandy loam. Results showed the samples taken under sod had a greater capacity to retain available moisture than the corresponding samples taken from the field, with one exception. Likewise, with one exception the samples taken under sod had a greater organic matter content. A study of the data by Fisher's method showed a direct correlation between organic-matter content of the soils and their capacity to hold available moisture, with a correlation coefficient of 0.728.

The Base-Exchange Capacity of the Organic and Inorganic Fractions of Several Podzolic Soil Profiles—Tedrow, J. C. F. and Gillam, W. S.—*Soil Science*. 51: 223-233. 1941. [Journal Article 458 (n.s.) from the Mich. Agri. Exp. Sta.]—The base-exchange capacity of the organic and inorganic fractions of the A_1 , A_2 , B_1 , B_2 and C horizons of several virgin podzolic soil profiles were studied. These results, as well as data showing the percentage of the total base-exchange capacity due to the organic and inorganic fractions, and the absolute exchange capacity of the organic fractions were plotted in three separate figures.

The organic matter present in the A_1 horizons studied accounted for 64 to 86 per cent of the base-exchange capacity of these horizons. Similarly, the organic base-exchange capacity constituted 42 to 62 per cent, 29 to 84 per cent, and 17 to 85 per cent of the total base-exchange capacity of the A_2 , B_1 and B_2 horizons, respectively.

A wide variation in the absolute exchange capacity of the organic fraction was noted, not only among the different soil profiles but also between horizons within the same profile. It was concluded that this variation was caused by differences in the chemical nature of the organic matter.

The exchangeable calcium and magnesium in many of the horizons were also determined.

Manganese, Copper and Magnesium Contents of Some Commercial Fertilizers—Millar, C. E. and Gillam, W. S.—*Jour. Am. Soc. Agron.* 32 (9): 722-725. 1940. [Journal Article 459 (n.s.) from the Mich. Agri. Exp. Sta.]—In recent years research has directed attention to the requirement of plants for small quantities of such elements as copper,

manganese, and magnesium and the question has arisen as to the amounts of these elements contained in standard mixed fertilizers used largely by farmers. To obtain some information on this subject, 11 samples of 2-12-6 fertilizer were analyzed for the elements mentioned. The results showed a variation in manganese content, expressed as anhydrous MnSO_4 , from a trace to 0.018 pound per ton. Copper content, in terms of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, varied from 0.000,000,12 to 0.000,4 pound per ton. One sample contained magnesium equivalent to 17.78 pounds of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ per ton. In the other samples the $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ equivalent of the magnesium content varied from 0.42 to 6.02 pounds per ton. Considering the requirement of commonly grown grain crops for those elements and the fact that a small fraction of a ton of fertilizer is usually applied per acre, it appears that crops must depend very largely on the soil for the amounts of these elements needed.

A Photometric Method for the Determination of Magnesium—

Gillam, W. S.—Ind. and Eng. Chem. (Anal. Ed.) 13: 499-501. 1941. [Journal Article 467 (n. s.) from the Mich. Agri. Exp. Sta.]—A rapid and reliable method of analysis for small quantities of magnesium was developed. It is based on the fact that in an alkaline solution magnesium ions react with titan yellow to produce a pink or red color, which can be readily matched with standards or read in a photoelectric colorimeter. Hydroxylamine hydrochloride was used as a stabilizer. The method is applicable for the determination of magnesium in quantities ranging from 0.5 p.p.m. to 300 p.p.m., and calcium, up to a maximum concentration of 800 p.p.m. did not interfere.

Results from the analysis of several commercial fertilizers, tap water, and soil extracts are given. Likewise a comparison of results obtained by this method and by the hydroxyquinolate gravimetric method are listed.

A New Microscopic Procedure for the Detecting and Locating of the Source of Thermophilic Organisms in Milk—

Mallmann, W. L., Bryan, C. S., and Fox, W. K.—Jour. Milk Tech. 4 (4): 195-199. 1941. [Journal Article 475 (n. s.) from Mich. Agri. Exp. Sta.]—Heat-resistant bacteria in milk are indicators of unclean equipment used or of insanitary procedures in producing milk. Considerable difficulty has been experienced with high bacterial counts since the adoption of the new standard agar for plate counts of milk. This has been due largely to the fact that the new medium favors development of organisms that on the old medium failed to grow or grew so poorly that the colonies were too small to count at the end of the 48-hour incubation period. High counts on the new medium have been especially frequent in pasteurized milk. Data collected indicate that the high counts obtained are frequently due to the presence of thermophilic bacteria and not to improper pasteurization of the milk. The only reliable method of detecting thermophilic bacteria in milk has been the pasteurizing test. Briefly, this test consists of determining the bacterial counts before and after laboratory pasteurization. This gives excellent results for dairies with a small number of producers but the test is too cumbersome to be applied to large dairies with a large number of producers. Tests were made to determine the effect of long incubation at high temperature on the dead bacteria that would result from incubation at these temperatures.

The data indicate that a microscopic clump count made at the end of two hours of incubation of raw milk at a temperature no lower than 58° C. shows the presence of thermoduric bacteria on milk. An arbitrary standard of 40,000 per cubic centimeter in the milk incubated 58° C. for two hours was set as a limit for the presence of objectionable numbers of thermoduric bacteria.

Report on Chlorophyll and Carotene in Plant Tissue—Benne, E. J.—*Jour. Assoc. Off. Agr. Chem.* 24 (3): 526-539. 1941. [Journal Article 480 (n. s.) from the Mich. Agri. Exp. Sta.]—Recently there have been proposed for the evaluation of carotene in plant materials, numerous new or modified procedures that are said to effect more thorough separation of other pigment impurities, to lessen manipulative details, or to overcome difficulties presented by individual plant tissues. In general, the same is true of chlorophyll, although less work has been done on methods for evaluating this pigment.

Consequently, it appeared of value to subject as many as possible of these new procedures to a collaborative study among other investigators interested in such work. Workers in seven laboratories besides that of the Associate Referee participated in this study which included seven methods for evaluating carotene and two for chlorophyll. The results and comments from the different collaborators are given in the published report.

Report on Zinc in Plants—Cowling, H.—*Jour. Assoc. Off. Agr. Chem.* 24 (3): 520-525. 1941. [Journal Article 481 (n. s.) from the Mich. Agri. Exp. Sta.]—Before his appointment as Associate Referee on Zinc in Plants the author had developed a photometric dithizone method for the determination of zinc in plant tissues that proved to be accurate and remarkably free from interferences by other cations that form colored complexes with dithizone.

Inasmuch as this method appeared to be more accurate and sensitive than the method given at present in *Methods of Analysis*, A.O.A.C., it was decided to offer it for collaborative study among others interested in such work. Investigators in four other laboratories cooperated, and the results of their analyses agreed well with those of the Associate Referee. Consequently, it was recommended that the method be adopted tentatively by the Association of Official Agricultural Chemists.

Grouping of Strains or Varieties by Use of the Latin Square—Baten, W. D., Northam, J. I., and Yeager, A. F.—*Jour. Am. Soc. Agron.* 33: 616-622. 1941. [Journal Article 486 (n. s.) from the Mich. Agri. Exp. Sta.]—This paper describes a layout of 64 strains of tomatoes in groups of 16, planted in a 4 x 4 Latin square and contains statistical analyses pertaining to the yields from these strains. Technics are presented for arriving at valid experimental errors when certain error variances are heterogeneous and tests are given for comparing the mean of groups, the means of strains within a group and the means of strains in different groups. A statistical analysis is given when estimates are made for certain extraordinary plot yields.

A Colchicine-Induced Tetraploid Cosmos—Newcomer, E. H.—*Jour. Heredity.* 32 (5): 160-164. 1941. [Journal Article 491 (n. s.) from the

Mich. Agri. Exp. Sta.]—Treatment of the apical growing points of seedlings of the Early Sensation variety of cosmos resulted in the production of a number of plants whose cells showed twice the normal (diploid) number of chromosomes. Associated with this tetraploid condition was an increase in size of flowers, epidermal cells, stomatal guard cells and seeds. A pronounced increase in thickness of the cell walls accounted for the slight increase in size of the tetraploid pollen grains.

Available Boron as Affected by Soil Treatments—Muhr, G. R.—Soil Sci. Soc. Amer. Proc. 5: 220-226. 1941. [Journal Article 493 (n. s.) from the Mich. Agri. Exp. Sta.]—Soybeans grown in pot cultures of 11 different Michigan soils, to which were added various treatments, were analyzed for boron, calcium, magnesium, iron and nitrogen. Calcium carbonate and $MgCO_3$, applied to Warsaw sandy loam and Hillsdale sandy loam B horizon soil, both acid soils, reduced the boron content of the soybean tissue. Sodium carbonate and Na_2SO_4 did not alter the boron content of soybeans on these soils. Calcium sulphate and $MgSO_4$ did not alter the boron content of the tissue of soybeans grown on the Hillsdale soil not treated with borax, but reduced the boron content of those grown in pots where excessive borax had been applied. Accumulations of calcium and nitrogen accompanied an excessive boron content in the plant tissue. The soil constituents, active calcium, organic matter and clay, which prevent applied borax from becoming toxic to soybeans, prevent boron from accumulating in the plant tissue. Yields were increased with applications of borax until the boron content of the dry plant tissue reached 30 p.p.m. It was found that borax becomes toxic to soybeans when the boron content of the dry tissue reaches 50 to 60 p.p.m. The magnesium and iron contents of soybeans were not greatly altered by toxic quantities of borax.

To ascertain the effect of hydrogen ion concentration on the availability of boron, sugar beets were grown in an alkaline soil, deficient in available boron and were treated with borax and sulphur, singly and in combination. A quantity of sulphur sufficient to lower the pH from 7.5 to 6.2 was as efficient as borax in preventing heart rot.

It was found that fixation of boron in an alkaline sandy soil, high in organic matter, was not instantaneous but a rather slow process. This was indicated by a reduction in the toxic effect of boron on soybeans when planting was delayed for two months after the borax was applied.

The Effect of Borax on the Yield, Appearance, and Mineral Composition of Spinach and Sugar Beets—Cook, R. L. and Millar, C. E.—Soil Sci. Soc. Amer. Proc. 5: 227-234. 1941. [Journal Article 499 (n. s.) from the Mich. Agri. Exp. Sta.]—Sugar beets and spinach, grown in the field on alkaline soils deficient in boron, were treated with borax at variable rates of application. Yields were measured in the field, and dried plant samples were analyzed for boron, nitrogen, iron, calcium, and magnesium. Sugar beets were also grown in the greenhouse and were treated with different quantities of ammonium nitrate at different levels of available boron.

Borax, applied at the rate of 20 pounds per acre as a side dressing for sugar beets on Wisner silt loam, virtually eliminated heart rot

symptoms, and caused (a) the yield to increase from 7.16 tons to 14.30 tons per acre and (b) the sucrose content and purity to increase from 14.11 to 18.02 per cent and from 80.92 to 84.91 per cent, respectively. Applied broadcast for spinach at the rate of 10 pounds per acre, borax prevented the appearance of boron-deficiency symptoms and caused the yield to increase from 8.1 to 14.3 pounds per plot. On the plots which did not receive borax, the spinach plants developed symptoms almost identical with symptoms of heart rot in sugar beets.

Applications of borax increased the boron content of the dry tissue of sugar beet roots and of spinach roots and tops and reduced the nitrogen content of sugar beet and spinach roots.

Ammonium nitrate, applied to pot cultures of Thomas sandy loam, caused a decrease in the boron content of sugar beet roots.

Applications of borax caused a decrease in the percentage of iron in sugar beet roots and spinach tops.

In one pot culture experiment, borax was found to be the cause of an increase in the percentage of magnesium in sugar beet roots.

Borax had no effect on the calcium content of either sugar beets or spinach.

Effect of Mulching Materials on Moisture Loss from Soils—Turk, L. M. and Partridge, N. L.—Proc. Am. Soc. Hort. Sci. 38: 59-62. 1941. [Journal Article 502 (n. s.) from the Mich. Agri. Exp. Sta.]—Data are presented concerning the amount of percolate collected below shallow lysimeters in which the soil was covered with various mulching materials. Although the relative amount of water collected during four periods varied somewhat between the differentially treated series, the lysimeters with no mulch and those with peat for a mulch gave small amounts of drainage water and the lysimeters where other mulching materials (gravel, sawdust, shavings, straw, alfalfa hay and stover) gave considerably larger quantities of percolate during the same time. The differences between the amounts of percolate obtained beneath these more effective materials differed only slightly and their effectiveness in water conservation appeared to be in the order in which they are listed above, with gravel most effective and stover less so.

The Correlation of Trunk Circumference with Weight of Top in Some Double-worked Apple Trees—Hewetson, F. N.—Proc. Amer. Soc. for Hort. Sci. 38: 341-344. 1940. (1941.) [Journal Article 503 (n. s.) from the Mich. Agri. Exp. Sta.]—A group of Steele trees were cut off at the union of scion and interstock, or scion and seedling, according to the buildup of the tree, and the tops weighed. The weights of these tops were then correlated with the trunk circumferences and areas of trunk cross section. The coefficients of correlation were respectively $.910 \pm .018$ and $.921 \pm .016$. By means of a regression equation based on all the trees in this experiment, it was possible to estimate weight of top from trunk circumference measurements to within 16 per cent.

Seed Production of Smooth Brome Grass as Influenced by Applications of Nitrogen—Harrison, C. M. and Crawford, W. N.—Jour. Am. Soc. Agron. 33 (7): 643-651. 1941. [Journal Article 507 (n. s.) from the Mich. Agri. Exp. Sta.]—Smooth brome grass, (*Bromus inermis*), was planted in 28-inch rows and fertilized with ammonium sulphate at

varying rates and dates of application. Nitrogen applied in April and May of the first seed year resulted in seed yields greater than the controls, whereas the same applications in June did not consistently stimulate seed yields. In the second seed year, applications in April resulted in marked increases in seed yield, the May treatments were not as effective and the June treatments were only slightly greater than the control.

The number of fertile tillers and spikelets per panicle were only slightly influenced by applications of nitrogen; whereas the number of barren tillers and florets per spikelet were significantly increased. The protein content of the forage at seed harvest time increased consistently as the rate of application increased, June being the most effective date the first seed year and April in the second seed year. Forage production was stimulated most by the applications of nitrogen in May in the first seed year and by April applications in the second seed year.

Common Defects of Ice Cream, Their Causes and Control; A Review—Lucas, P. S.—*Jour. Dairy Sci.* 24 (4): 339-368. 1941. [Journal Article 511 (n. s.) from the Mich. Agri. Exp. Sta.]—This article is one of a series being sponsored by the Journal of Dairy Science to summarize in one article approximately all of the material published on some highly specialized phase of the dairy industry. The one mentioned contains in abstract form the results from 155 references. It contains material relative to the causes, preventive measures and remedies for flavor defects, body and texture defects and color defects of ice cream.

How to Determine Which of Two Variables Is Better for Predicting a Third Variable—Baten, W. D.—*Jour. Am. Soc. Agron.* 33: 695-700. 1941. [Journal Article 512 (n. s.) from the Mich. Agri. Exp. Sta.]—This article gives the details for applying Hotelling's test for determining which of two variables is better for predicting a third when the variables are linearly related. The test answers such questions as the following: Can a steer's weight be more accurately predicted from his heart girth than from some other body measurement? Can the area of a bean leaflet be more accurately predicted from the length than from the width? Two applications relating to agriculture are presented together with charts showing the geometric meaning of the test. The purpose of the article is to bring to the attention of research workers in agriculture this important test which can be applied in many ways.

Rancidity Studies on Mixtures of Raw and Pasteurized Milk—Larsen, P. B., Trout, G. M. and Gould, I. A.—*Jour. Dairy Sci.* 24 (9): 771-778. 1941. [Journal Article 515 (n. s.) from the Mich. Agri. Exp. Sta.]—This study was conducted to ascertain under what conditions and to what extent rancidity would occur in mixtures of homogenized and unhomogenized raw and pasteurized milk. The lipolytic changes which occurred were determined by titration of the milk and by organoleptic means. In mixtures of unhomogenized raw and homogenized pasteurized milk, acidity increases occurred with as little as one per cent of the unhomogenized milk. Increasing the percentage of the unhomogenized milk in increments up to 50 per cent increased the rate and

extent of acidity development, whereas further increases resulted in a decrease in the acidity. The maximum acidity developed over a period of 10 days occurred when the ratio of unhomogenized raw milk and homogenized pasteurized milk was 1:1. Rancidity was definitely detected after 7 to 10 days of storage when the mixture contained 5 to 95 per cent of the raw milk or 5 to 95 per cent of the homogenized pasteurized milk.

Mixtures of homogenized raw and homogenized pasteurized milk showed a greater acid development than in the trials in which the raw milk was unhomogenized. Furthermore, the rate and extent of acidity development varied directly with the amount of raw homogenized milk present, with the maximum development resulting in the sample consisting entirely of the raw milk. Development of the rancid flavor correlated closely with acidity changes.

Mixtures of unhomogenized and homogenized raw milk gave results somewhat similar to those secured when mixtures of homogenized raw and homogenized pasteurized milk were used.

The development of rancidity in milk mixtures appears to be equally dependent upon the amount of lipase present and upon the amount of acceleration afforded by the newly created surfaces.

Oxidation-Reduction Potentials and the Oxidized Flavor in Homogenized Milk—Larsen, P. B., Gould, I. A. and Trout, G. M.—*Jour. Dairy Sci.* 24 (9): 789-793. 1941. [Journal Article 516 (n. s.) from the Mich. Agri. Exp. Sta.]—Oxidation-reduction potentials were determined on both unhomogenized and homogenized milk. In certain trials, copper was added to the milk at the rates of one and three p.p.m. Homogenization was at 1,500 and 2,500 pounds pressure. The results showed that the Eh in both unhomogenized and homogenized milk exhibited the same trend, whereas the milk samples showed differences in susceptibility to oxidized flavor development. Unhomogenized milk which became oxidized showed increases in potential. In contrast, the same milk when homogenized underwent similar changes in potential but showed little or no tendency to become oxidized.

Effect of Certain Factors upon Lipolysis in Homogenized Raw Milk and Cream—Gould, I. A.—*Jour. Dairy Sci.* 24 (9): 779-788. 1941. [Journal Article 518 (n. s.) from the Mich. Agri. Exp. Sta.]—Fat from milk or cream homogenized at 500-1,000 pounds pressure was titrated for free fatty acids. The influence of the following factors was observed: copper, salt (NaCl), formalin, storage temperature, and different fractions of milk. In addition, correlation between free fatty acids and formation of peroxides was observed. The results showed that neither copper salts in amounts as high as 10 p.p.m., nor formalin in ratio of 1:250, when added to the milk or cream affected the speed or extent of lipolysis. Salt markedly reduced lipolysis when added at the rate of two per cent, and almost completely prevented lipolytic activity when used at the rate of five per cent. Fat in homogenized raw milk underwent 12-fold more lipolysis at 70° F. than at 35° F., whereas the fat in the milk stored at 35° F. showed approximately twice as much hydrolysis as that in the milk held at 0° F. Pasteurization of cream and skimmilk fractions showed the active agent of lipolysis to be associated with the milk plasma. Further, precipitation of the casein

by rennet and homogenizing fat in raw whey, showed that the whey exhibits definite lipolytic activity although the major portion of the activity of skimmilk was lost with the removal of the casein. No significant relationship was observed between the extent of lipolysis in the homogenized products and the peroxide number.

The Use of Egg Containers Treated With a Mycostat in Commercial Cold Storage—Mallmann, W. L. and Carr, R. E.—U. S. Egg and Poultry Magazine. 47: 344-347. 1941. [Journal Article 526 (n. s.) from the Mich. Agri. Exp. Sta.]—Eggs were stored in penta-chloro-phenol-treated fillers and flats that were manufactured on a commercial scale. These were placed in four warehouses in the regular egg storage rooms for a period of six months. At the end of this period the eggs were removed and examined for quality; examinations were also made for the appearance of molds on the eggs and their containers. Penicillia were absent from all treated eggs, fillers and flats. The treatment of fillers and flats with penta-chloro-phenol was found to be successful in preventing mold spoilage in commercial storage. No off-taste or odors were found in eggs stored in treated fillers and flats.

A Comparison of Dowicide A and Chlorine (Diversol) for Use in Milking Machines—Fabian, F. W. and Nielsen, G. L.—Jour. Milk Technology. 4 (5): 268-275. 1941. [Journal Article 533 (n. s.) from the Mich. Agri. Exp. Sta.]—A comparison was made between Dowicide A (Na orthophenolphenate) and chlorine (Diversol) for use in sanitizing milking machines. The experiments were conducted over a six-month period, using three milking machines—a control, one sanitized with Dowicide A and one with Diversol. Bacterial plate counts were run on the rinse water and from milk from the machines. Samples were also tested for thermophilic bacteria. Phosphatase tests were run on all samples of pasteurized milk from the machines with negative results. The results showed that a 1:200 solution of Dowicide A compared very favorably with a solution of Diversol containing from 102 to 188 p.p.m. of available chlorine. Dowicide A acted more quickly than Diversol against known strains of thermophiles, indicating its usefulness as a rinse. Dowicide A was more stable than Diversol, showing germicidal properties after two weeks.

Terminal Cerebrospinal Fluid Pressure Values in Vitamin A Deficiency—Moore, L. A. and Sykes, J. F.—Am. Jour. Physiol. 134: 436-439. 1941. [Journal Article 534 (n. s.) from the Mich. Agri. Exp. Sta.]—In a previous study, Moore and Sykes reported that increased pressures of the cerebrospinal fluid accompanied Vitamin A deficiency in cattle. The pressures observed in the terminal stages of Vitamin A deficiency were subsequently determined in a number of instances and are reported in this communication.

When the deficiency was allowed to proceed to the stage where convulsions were easily brought on by excitement and to the point where difficulty in movement was evident, very marked increases in pressure were observed. Pressures as great as 600 mm. of saline occurred. There was a tendency for the pressure to recede when the animals became prostrated and were in a more or less morbid state, but it was still much above the normal level. A possible relationship

between the elevated pressure and the symptoms observed is discussed. The causative factors responsible for the increased pressure are not known.

Failure of Natural *Vibrio Fetus* Infection to Carry Over in Ewes—

Ryff, J. F.—Am. Jour. Vet. Res. 2 (4): 367-368. 1941. [Journal Article 541 (n. s.) from the Mich. Agri. Exp. Sta.]—Extensive *Vibrio fetus* infection in a Michigan flock of 79 sheep—as indicated by recovery of the organism from four aborted lambs, a positive agglutination test in 1:25 dilution in 37 sheep, and the loss of 37 lambs from 28 ewes owing to abortion, stillbirth, or weakness—was not carried over to the following lambing season. Ninety-six viable lambs were obtained and only five were lost from 80 ewes in 1941, although the animals were kept on the same ground and received feed and water from the same source as before.

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